

**WATCHING THE DETECTIVES** Big data snitches on bad cops

# NewScientist

WEEKLY May 30 - June 5, 2015

## GETTING AWAY WITH IT

The guilty pleasures you can sometimes  
indulge – and the ones you can't



## THE CAT MADE ME DO IT

Feline parasites that mess with your mind

### GRAPHENE ROCKET

Off to space on  
a carbon sail

### HYDRA EFFECT

When killing things  
makes them stronger

### ONE STEP AHEAD

The robot arm that  
knows what you want

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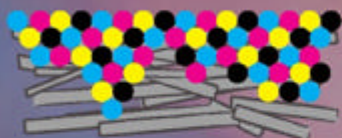


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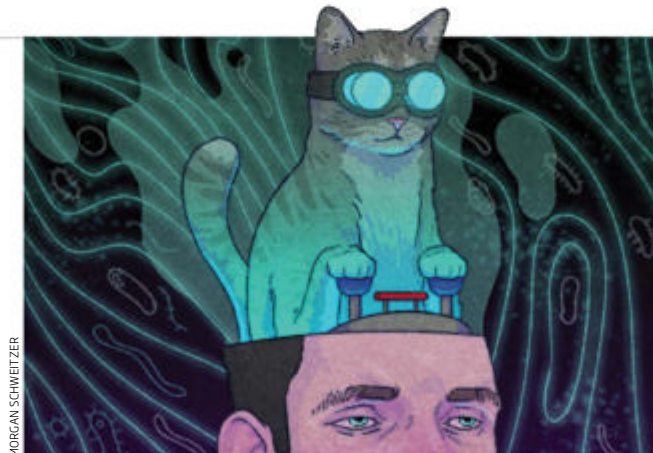


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EMILIE LOREAU/PICTURETANK

# It takes a village

We need to rebuild online social networks as real communities

IF FACEBOOK was a country, it would be the world's most populous nation: more than 1.4 billion people use it every month. Other social media giants – such as WhatsApp, Google+, LinkedIn, Twitter and Chinese messaging service Tencent QQ – would also appear in the top 10.

But what kind of countries would these be? In Facebookland, the authorities choose what news you see and suppress updates they consider to be unsuitable. They encourage you to report fellow citizens whose behaviour offends you; the statute book is vague about what constitutes an offence and the sanctions meted out seem arbitrary and draconian. Summary exile is common.

It sounds like a police state. Of course, Facebook is not a country; it has no statutory duty of care to users. The “authorities” are often algorithms, not apparatchiks. And its “inhabitants” can up and leave whenever they like.

Or can they? How many telephone numbers can you dial from memory? Probably far fewer than you once could, if you grew up before mobile phones became common. And if you grew up after that, it's probably only a handful, for use in emergencies.

A similar migration may now be under way with our families

and friendships. Network effects make social media powerful: as more and more of our social life moves online, it has become increasingly hard to quit. FOMO – “fear of missing out” – is an increasingly rational concern. For those approaching adulthood, many of whom view social networks as synonymous with the internet, it is a fact of life. Yes, you can leave Facebookland. But where would you go?

Chances are you would move to another network, and millions

**“No one knows quite what our new social norms are, how they were decided, or how to change them”**

have indeed defected. But all such networks have similar problems. Renouncing them altogether is not the answer either. Billions of people use these services because they enhance their lives. So we should think harder about how we use them, and how they shape the communities they underpin. Our behaviour is governed by a new set of norms, but none of us is really sure what they are, how they were decided – or how we could or should change them.

Much of the conflict that arises online is the product of confusion over these new norms, worsened

by overly blunt tools for resolving it. The tools have to be rigid to help human moderators cope with millions of requests for online peacekeeping. Let people act more like people do when they meet in person, as Facebook is now trying to, and conflicts seem to blow up less often (see page 38).

Contradictory though it may sound, machines may be able to help too. Right now, only humans can hope to parse the nuances of such requests. Smart computers might be able to ease the load, but that won't be easy. A meeting at the Royal Society in London last week heard that machine learning is being held back by chip design, which concentrates too much on arithmetic and not enough on communication. You could not hope for a more fitting metaphor.

So we may need to work from the very bottom up, but it is vital we reimagine the online world. As Thomas Paine, philosopher of the American Revolution, argued: new societies give us a chance to redefine our social norms. “We have it in our power to begin the world over again.”

“If there must be trouble, let it be in my day, that my child may have peace,” he added. Social networks are here to stay. We owe it to future generations to turn them into real communities. ■



AP PHOTO



Tornado's aftermath

## Ragweed invasion

DO YOU have a pollen allergy? Then you have even more reason to worry about climate change. A North American plant that releases copious amounts of pollen looks set to massively expand its range in Europe.

**"Extra carbon dioxide in the atmosphere will nourish ragweed and help it produce even more pollen"**

Ragweed is abundant in North America, where a quarter of people are sensitised to it. It is the third largest allergy trigger, after dust mites and rye grass pollen. In Europe it is an invasive species, mainly found in northern Italy and southern France.

But it is set to spread east and north, reaching Ukraine and the UK by mid century. "By 2050, airborne ragweed pollen concentrations will increase by a factor of 4," warns Lynda Hamaoui-Laguel of the Laboratory of Climate Science and the Environment in Gif-sur-Yvette, France (*Nature*

*Climate Change*, doi.org/4tf).

With rising temperatures and longer summers, more plants will complete their life cycle and produce seeds. Extra carbon dioxide in the atmosphere will nourish ragweed, helping it produce even more pollen.

As few as 20 ragweed pollen grains per cubic metre of air can provoke an allergic response. "It's most likely to affect those who already suffer from hay fever and react to pollen from birch trees, and to grass and weed pollens," says Maureen Jenkins of the charity Allergy UK.

## Signs of El Niño chaos

WILD weather in Mexico, Texas, Oklahoma and Alaska could be the first hints of the havoc that El Niño is likely to wreak this year.

A five-year drought in parts of Texas and Oklahoma has dramatically broken – with floods that have burst dams, washed away houses and taken at least five lives. In Texas the rains came suddenly over the weekend. "This is the biggest flood this area of Texas has ever seen," state governor Greg Abbott said on Monday.

Just south of the border from there, a tornado killed at least 13 people in the Mexican city of Ciudad Acuna on Monday. In Alaska temperatures pushed above 30 °C in places, causing snowmelt and flooding.

El Niño occurs when warm water wells up from the depths of the Pacific

Ocean and spreads east. It warms the globe and drags rain away from parts of Asia and Australia, dumping it on much of the west coast of the Americas.

The weather we are seeing is consistent with El Niño, says Wenju Cai of the CSIRO, Australia's national science agency, in Melbourne. He says this event looks set to be an extreme one. Jeff Knight from the UK Met Office says it's hard to pin all the wild weather on El Niño, but it is probably a factor.

Also in play is a weird blob of warm water that is warming the air off the US West Coast. And global warming isn't helping, Knight says. "Global warming is a background tide that is rising, and we get all these features like El Niño on top of it," he says.

## Threat to treasures

AFTER ISIS stormed the Syrian city of Palmyra, the race is on to digitally record other ancient sites before it's too late.

In Iraq, ISIS has destroyed statues in Mosul, and Babylon is also at risk of being captured. But 3D scanning and pulling 3D data from photos could allow rebuilding. Both are being done as part of a project that scans heritage sites and ancient objects. The goal is to make ancient sites from across the world accessible online, but the 3D records of these

places and their treasures could also serve as a template for their reconstruction, if required.

Other projects are examining satellite imagery and old aerial photos to record damage to ancient sites, or trying to predict threats. A collaboration between the Universities of Oxford and Leicester, for example, could identify vulnerable sites before they come under attack.

Before retreating, the Syrian army evacuated many objects from Palmyra's museum, but the fate of the city's ancient buildings now depends on its invaders.

## Antelope deaths

"IT'S very dramatic and traumatic, with 100 per cent mortality," says vet Richard Kock, on the phone from Betpak-Dala in central Kazakhstan, where 27,000 saiga antelopes died of an unknown disease last week. "I know of no example in history with this level of mortality, killing all the animals and all the calves," says Kock, of the Royal Veterinary College in Hatfield, UK. The animals seem

REUTERS/KAZAKHSTAN'S MINISTRY OF AGRICULTURE



Sadder than Bambi

to be dying because of diarrhoea and breathing difficulty.

From tissue samples, Kock and his colleagues have identified three possible causes. One is haemolytic septicaemia, caused by bacteria that are normally harmless but can strike if the animals are weakened. Another, less likely culprit is epizootic haemorrhagic disease, a virus transmitted by mosquitoes. The other possibility is toxæmia caused by clostridia bacteria. In 2014, there were 200,000 saiga in Betpak-Dala and a further 60,000 in other regions, down from more than a million in the 1990s.

## LHC sees double

LET'S get smashing. A new record was set last week by the Large Hadron Collider at CERN, near Geneva in Switzerland, when it collided two proton beams together at a total energy of 13 teraelectronvolts.

The collisions were part of ongoing efforts to restart LHC experiments after a two-year upgrade to the world's biggest machine. They showed that the LHC can cope with energy levels almost twice those achieved during its previous run.

CERN engineers will continue to put the LHC through its paces, making sure everything is ready for the teams behind the various detectors to switch their experiments on. The official start of the LHC's second run, when experiments get under way for real, is expected to happen in early June.

Having found the Higgs boson in 2012, CERN researchers are hoping to learn more about it. They are also searching for signs of supersymmetry, a theory that suggests all members of the standard model of particle physics have a much heavier superpartner. Collisions at higher energies could reveal these partners and point the way to groundbreaking theories.

## Visual dilemma

FORGET coloured glasses – sight problems are not the source of reading difficulties in people with dyslexia, despite what charities and even some specialists say.

A study of nearly 6000 children in the UK has found little difference between the incidence of visual problems in those with and without dyslexia. In 2 of the 11 sight tests, children with dyslexia had slightly higher rates of problems – 16 per cent versus 10 per cent. But that small difference could be caused by the fact they read less, says author

Alexandra Creavin of the University of Bristol, UK. What's more, the 16 per cent figure is so low, it can't be the explanation for dyslexia (*Pediatrics*, doi.org/4tk).

Creavin says dyslexia charities should stop promoting products

**“Sight problems are not the source of reading difficulties in people with dyslexia”**

such as coloured overlays and tinted glasses – designed to change the background colour of a page – without making clear the doubts about their effect.

## Easy ride for space flights

A RIDE to space on a private rocket should be thrilling, yes? US politicians seem to agree this week, voting to let paying customers continue to fly at their own risk.

The SPACE Act of 2015 is the first major commercial space bill since 2004, when SpaceShipOne became the first private crewed vehicle to reach space. US regulations put in place at the time meant that the Federal Aviation Administration (FAA), which also covers the airline industry, would exercise a light touch with space firms as part of a learning period to let them experiment.

That provision is due to expire later this year, but last week the House voted to extend it for another 10 years. It means that the FAA can

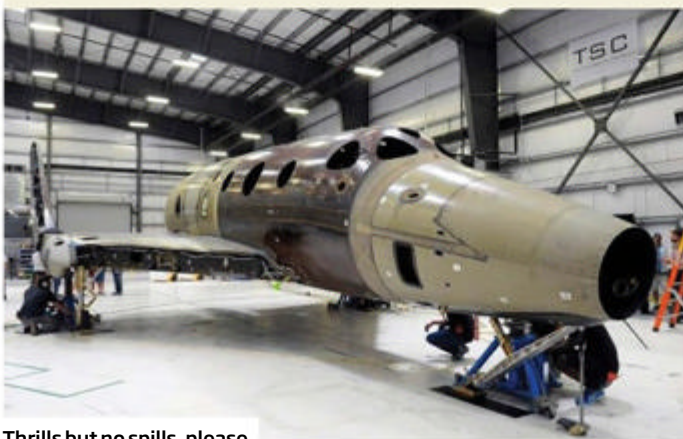
only step in after a major accident, such as the crash of Virgin Galactic's SpaceShipTwo last year.

Supporters of the bill argue it is too soon to restrict the industry. “This bill will encourage the private sector to launch rockets, take risks and shoot for the heavens,” said Lamar Smith, a Republican who chairs the House science committee.

But others are concerned that having no rules covering passenger safety for another decade is too lax. “Nearly every provision in this bill, in every conceivable way, gives preference to the priorities of the commercial space launch industry,” said Democrat Eddie Johnson.

The bill will now be debated in the Senate.

VIRGIN GALACTIC



Thrills but no spills, please

## 60 SECONDS

### US egg shortage

Bird flu is cracking the US egg supply. Since the infection took hold in the US in April, 40 million birds have been culled, including 10 per cent of the country's egg-laying chickens. As a result, the US is starting to see a shortage in eggs – their price has increased by about 85 per cent in the last month. Companies are looking at importing eggs or using egg substitutes.

### India swelters

A week of heat across India has killed more than 700 people, with the majority of deaths in the southern state of Andhra Pradesh. Temperatures reached 48 °C in some areas as dry, hot winds blew in from Pakistan.

### A beautiful mind gone

John Nash, the mathematical genius depicted in the film *A Beautiful Mind*, and his wife were killed in a car accident in New Jersey last week. Nash, who famously battled schizophrenia, was the only person to have won both the Nobel prize for economics and the Abel mathematics prize.

### Cure for bats

White nose syndrome has so far killed 5.7 million bats in North America, but all is not lost. Last week, 150 bats cured of the fungal disease were released back to the wild at the Mark Twain Cave Complex in Hannibal, Missouri. They had been exposed to soil bacteria that stop the fungus growing on the bats while they hibernate.

### Megawatt stars

Oooh, that's bright. NASA's Wide-field Infrared Survey Explorer telescope has discovered a galaxy 12.5 billion light years away that shines with the intensity of 300 trillion suns. The light is emitted by glowing gas around a huge black hole at the centre of the galaxy, which is heated up as it falls inside (*Astrophysical Journal*, doi.org/4tm).



# I think, therefore I can

A brain implant that decodes intention is helping paralysed people gain more independence – and letting us probe the nature of desires

Helen Thomson

IMAGINE a world where you think of something and it happens. For instance, what if the moment you realised you wanted a cup of tea, the kettle started boiling?

That reality is on the cards, now that a brain implant has been developed that can decode a person's intentions. It has already allowed a man paralysed from the neck down to control a robotic arm with unprecedented fluidity.

But the implications go far beyond prosthetics. By placing an implant in the area of the brain

**"You could identify the brain activity for wanting to watch a film and have that turn on the TV"**

responsible for intentions, scientists are investigating whether brain activity can give away future decisions – before a person is even aware of making them. Such a result may even alter our understanding of free will.

The implant was designed for Erik Sorto, who was left unable to move his limbs after a spinal cord injury 12 years ago. The idea was to give him the ability to move a stand-alone robotic arm.

People with similar injuries have previously controlled prosthetic limbs using implants in their motor cortex – an area of the brain responsible for the mechanics of movement. But this is far from ideal because it results in delayed, jerky motions as the person thinks about all the individual steps of a longer action.

Richard Andersen at the California Institute of Technology in Pasadena and his colleagues hoped they could achieve more fluid movement by placing an

implant in the posterior parietal cortex – a part of the brain used in planning movements.

"We thought this would allow us to decode brain activity associated with the overall goal of a movement – for example, 'I want to pick up that cup', rather than the individual components," Andersen told delegates at the NeuroGaming Conference in San Francisco earlier this month.

The two tiny electrodes implanted in Sorto's posterior parietal cortex were able to record the activity of hundreds of individual neurons. Then, with some training, a computer was able to match patterns of activity with Sorto's intended movement.

“We found there was amazingly specific activity for specific gestures,” says Andersen. For example, certain neurons fired

when Sorto imagined moving his right hand to the back of his head, and others when he wanted to move his left hand to his lips.

Once this neuronal information had been collected, a computer translated Sorto's intentions into movements of a robotic arm. This enabled him to control the speed and trajectory of the arm, so he could shake hands with people, play rock, paper,



SPENCER KEILS

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scissors and switch on a blender to make a smoothie.

Most importantly to Sorto, he was able to pick up a beer and swig it at his own pace (*Science*, doi.org/4tp). "It's awesome, it's awesome," Sorto repeated, after drinking his beer. "I hope some day that people with these conditions will have a robotic arm and regain some sort of independence," he says.

Andersen's team is also working on giving people like Sorto back their sense of touch by placing a similar implant in the somatosensory cortex. People who have had this region stimulated during brain surgery have reported feeling things

such as "a wind rushing over my hand" or "my finger being wrapped in something".

At the conference, Andersen announced that his team had placed such an implant in their first volunteer and is working out how to replicate realistic perceptions of touch by stimulating this brain area.

## Desires laid bare

Another tantalising possibility is using other intentions decoded from brain activity to control our environment. For example, could we identify the pattern that corresponds to the thought of wanting to watch a film, then have that switch on the television?

To investigate the feasibility, Andersen's team had a person with a similar implant to Sorto's play a version of the prisoner's dilemma, where players can either collaborate or double-cross one another. The team was able to predict the volunteer's decision based on the neural activity the implant recorded. This showed that more abstract decisions such as, in this case, the intention to snitch on a hypothetical partner, can indeed be decoded from the posterior parietal cortex.

Ori Cohen from the Advanced Virtuality Lab at the Interdisciplinary Center in Herzliya, Israel, says that using abstract commands for brain-computer interfaces is a promising idea. "After all, this is how we control our body – we have a goal such as getting coffee and our brain kick-starts a range of processes involving complex geometrical computations in order to achieve it," he says.

Eventually, he believes that a person with paralysis could imagine themselves making a cup of coffee and have a humanoid robot automatically carry out the action. He is hopeful that such approaches could one day be achieved using non-invasive techniques, such as recording brain activity with an EEG

## MIND CONTROL IN YOUR LIVING ROOM

As our ability to decode brainwaves improves (see main story), the market for mind-reading devices that can be used at home is growing. Some estimates predict this market could be worth as much as \$6 billion by 2020. At the NeuroGaming Conference in San Francisco, companies were showing off a range of devices – scientifically validated to varying degrees.

An example is NeuroMage – one of the first computer games to harness the power of the mind to control a character using an EEG headset. Players must use certain kinds of thoughts to build up an armoury of spells to cast on opponents.

If you have trouble concentrating, MUSE might be more up your street. This app, combined with an EEG headset, teaches you to focus your attention using brain training exercises, and promises to improve your emotional well-being. The system is being tested by several US universities.

Then there's Foc.us EDGE – the world's first brain stimulation device aimed at improving your fitness. It involves a portable headset that sends a low current



FOCUS

to the temporal lobe. The idea comes from a study in which professional cyclists showed a 4 per cent improvement in stamina when they received a similar kind of stimulation. The researchers involved – who have not endorsed any Foc.us product – suggest that stimulating the temporal lobe can affect how difficult a workout feels (*British Journal of Sports Medicine*, doi.org/4r7).

While there is no evidence to suggest that short bursts of stimulation can damage the brain, many researchers at the conference were still wary of such devices, since they do not need to be approved by medical regulators.

headset, rather than having to embed electrodes in the brain.

Others are not so sure. "It's hard to get really high-quality brain signals with non-invasive technology," says Jörn Diedrichsen, a neuroscientist at University College London. He thinks this might be off-putting to those who

**"If decisions can be decoded before we're even aware of them, what does this mean for free will?"**

have no medical need to link up with their environment. "You have to ask whether you'd want to have invasive surgery to not have to press a button on a remote control," he says. "It might be technically possible in five to 10 years, but would you do it?"

The most intriguing aspect of Andersen's work, he says, is that we are now able for the first time to record the brain activity underlying intentions while asking about a person's conscious experience. For example, Andersen's team has already started to repeat classic free will experiments in which researchers try to use brain activity to predict a person's decisions before they are consciously aware of making any.

"We will be able to look carefully into big philosophical questions of whether a person's future decisions can be decoded from their neural activity before the individual is aware of having formed them – and what that all means for our ideas on free will," says Diedrichsen. "It really captures the imagination." ■



Got a grip on his intentions



## Beware space mining's dusty threat to satellites

IF THE gold mine is too far from home, why not move it nearby? It sounds like a fantasy, but would-be miners are already dreaming up ways to drag resource-rich space rocks closer to home. Trouble is, that could threaten the web of satellites around Earth.

Asteroids are not only stepping stones for cosmic colonisation, but may contain metals like gold, platinum, iron and titanium, plus life-sustaining hydrogen and oxygen, and rocket-fuelling ammonia. Space age forty-niners can either try to work an asteroid where it is, or tug it into a more convenient orbit.

NASA chose the second option for its Asteroid Redirect Mission, which aims to pluck a boulder from an asteroid's surface and relocate it to a stable orbit around the moon. But an asteroid's gravity is so weak that it's not hard for surface particles to escape into space. Now a new model warns that debris shed by such transplanted rocks could intrude where many defence and communication satellites live – in geosynchronous orbit.

According to Casey Handmer of the California Institute of Technology in Pasadena and Javier Roa of the Technical University of Madrid in Spain, 5 per cent of the escaped debris will end up in regions traversed by satellites. Over 10 years, it would cross geosynchronous orbit 63 times on average. A satellite in the wrong spot at the wrong time will suffer a damaging high-speed collision with that dust.

The study also looks at the “catastrophic disruption” of an asteroid 5 metres across or bigger. Its total break-up into a pile of rubble would increase the risk to satellites by more than 30 per cent ([arxiv.org/abs/1505.03800](https://arxiv.org/abs/1505.03800)).

That may not have immediate consequences. But as Earth orbits get more crowded with spent rocket stages and satellites, we will have to worry about cascades of collisions like the one depicted in the movie *Gravity*.

Handmer and Roa want to point out the problem now so that we can find a solution before any satellites get dinged. “It is possible

to quantify and manage the risk,” says Handmer. “A few basic precautions will prevent harm due to stray asteroid material.”

Mike Nolan of the Arecibo Observatory in Puerto Rico agrees it's an important issue. “They're right to consider it,” he says, “and their first stab indicates that the answer isn't obviously ‘don't worry.’” However, the risk is less concerning for asteroids not in this particular lunar orbit, he says.

Aspiring space miners are taking the risk seriously. “We will be utilising containment techniques,” says Meagan Crawford of Deep Space Industries, a California-based firm which hopes to be mining metals from asteroids by 2020. One possibility is bagging, in which the asteroid is placed in a kind of shroud to prevent dust and loose stones from escaping. “All of our mining targets will be chosen specifically to minimise the risk of particulate interaction with other bodies,” she says.

The risk from NASA's mission, planned for the 2020s, is small, Nolan points out. But if space mining takes off, things will get complicated. “The establishment of good asteroid mining practices early on is essential for the preservation of a non-renewable resource: uncluttered space,” says Handmer. **Sarah Scoles ■**



Not what you want in orbit

## Artificial DNA links up just like the real thing

TWO artificial DNA “letters” can link up just like the natural versions, paving the way for incorporating the newcomers into living cells.

Synthetic biologists are racing to come up with artificial versions of the building blocks of life. “We have been basically reinventing the genetic alphabet from the bottom up,” says Steven Benner of the Foundation for Applied Molecular Evolution in Alachua, Florida. Hopes for such fake DNA range from developing new

drugs to creating artificial life.

In 2006, Benner and his colleagues built two bases, dubbed Z and P, which bond together to form a pair (ZP) in a similar way to the two natural DNA base pairs – AT and GC.

Shortly after, in 2008, a group led by Floyd Romesberg at the Scripps Research Institute in La Jolla, California, built two more bases and showed that, just like DNA, natural enzymes could be used to replicate them. But their artificial base pairs were linked together into longer strands of DNA in a different way.

“What we know about normal DNA is you have runs of the same base, AAAA or TTTT,” says Millie Georgiadis of Indiana University in Indianapolis.

Because of the way they are joined together Romesberg's bases can't form such long runs.

Now Georgiadis and Benner have shown that their Z and P bases can form these runs, behaving just like natural DNA. Using X-ray crystallography they found that the bases could incorporate themselves into strands of both natural and unnatural bases that included runs of Z and P up to six bases long.

The researchers also showed that the strands took on the same two

forms that normal DNA uses inside cells: the familiar helical structure, called the “B” form, and a wider “A” form that DNA adopts when it is binding with a protein (*Journal of the American Chemical Society*, doi.org/4r9).

“DNA normally has to adopt different forms to interact with different sets of proteins,” Georgiadis says. “The fact that Z and P can adopt these forms suggests that [DNA made with these bases] will behave in a cell like natural DNA.” She says the ultimate goal is to “create new things”.

The work is impressive, says Romesberg. The ZP pair “can really function like a GC or an AT”, he says. **Lisa Grossman ■**

**“The fact that Z and P can adopt two forms suggests they will behave like natural DNA”**



RANIER UNDEL

Recovery is only a transplant away

# Fetal cells finally work in Parkinson's

Andy Coghlan

A MAN in his mid-50s with Parkinson's disease had fetal brain cells injected into his brain last week. He is the first person in nearly 20 years to be treated this way – and could recover full control of his movements in roughly five years.

"It seemed to go fine," says Roger Barker of the University of Cambridge, who is leading the international team that is reviving the procedure.

The treatment was pioneered 28 years ago in Sweden, but two trials in the US reported no significant benefit within the first two years following the injections, and the procedure was abandoned in favour of deep brain stimulation treatments.

What these trials overlooked is that it takes several years for fetal cells to "bed in" and connect properly to the recipient's brain. Many Swedish and North American recipients improved dramatically, around three years or more after the implants – long after the trials had finished. "In the best cases, patients who had

the treatment pretty much went back to normal," says Barker.

After the fetal cells were wired up properly in their brains, they started producing the brain signalling chemical dopamine – low levels of this cause the classic Parkinson's symptom of uncontrolled movements. In fact, the cells produced so much dopamine that many patients could stop taking their Parkinson's drugs. "The prospect of not having to take medications for Parkinson's is fantastic," says

## STEM CELLS - THE NEXT STEP

The team behind the fetal cell treatment (main story) hopes it will pave the way for bespoke stem cell treatments to replace the missing dopamine in people with Parkinson's disease. Rather than relying on fetal cells, these stem cell treatments could in theory be made to order.

Four teams – two in Europe and two in the US – have managed to make neurons from embryonic stem cells and all are hoping to use them to treat people with Parkinson's. Unlike fetal cells, these stem cells

James Beck of the Parkinson's Disease Foundation in the US.

Because the early trials missed this improvement no one had received fetal brain cells since the 1990s. But the man treated at Addenbrooke's Hospital in Cambridge on 18 May did not receive a full treatment, because the team only had enough cells to treat one half of his brain.

The transplant depends on fetal cell donations from women terminating pregnancies, so the researchers don't know when cells are likely to be available. It takes cells from at least three fetuses to treat each half of the brain, and four earlier attempts to treat the same man had to be stopped due to a lack of cells.

But Barker hopes to treat the

other half of the man's brain soon. "We would expect that if we do both sides, he will see an improvement in around six months to a year," says Barker. But the maximum benefits are predicted to happen in three to five years' time, and should then be sustained for more than a decade, he says.

The team plans to test the treatment in a further 19 people, in a trial split between Cambridge and Sweden.

Barker sees the revival of the technique as a stepping stone to injecting dopamine-producing cells made by stem cells (see "Stem cells – the next step"). Trials of such treatments are expected as early as 2017, and Barker hopes lessons learned from the fetal cell transplants will guide how to apply and assess them once they are ready.

"We are now on the road towards a 2.0 version of the cell therapy paradigm," says Lorenz

**"In the best cases, patients who had the treatment pretty much went back to normal"**

Studer of the Memorial Sloan Kettering Cancer Center in New York. He thinks future treatment will eventually involve the use of dopamine neurons that come from stem cells rather than fetal cells, which will permanently resolve the supply problem.

Members of the Parkinson's Disease Global Force met in New York last week to discuss the progress of this stem cell work. When Barker announced that his team's first patient had just left the operating theatre, the meeting's attendees burst into spontaneous applause.

"There's a real sense within the community that this is a collaborative effort to make cell treatments work, and that there's real potential to change the lives of hundreds of people worldwide," said Barker. ■



# Spacecraft may fly on graphene wings

Jacob Aron

GRAPHENE to the stars. The material with amazing properties has just had another added to the list. It seems these sheets of carbon one atom thick can turn light into action, maybe forming the basis of a fuel-free spacecraft.

Graphene was discovered accidentally by researchers playing with pencils and sticky tape. Its flat structure is very strong and conducts electricity and heat extremely well. Yongsheng Chen of Nankai University in Tianjin, China, and his colleagues have been investigating whether larger arrangements of carbon can retain some of these properties. Earlier this year they published details of a “graphene sponge”, a squidgy material made by fusing crumpled sheets of graphene oxide.

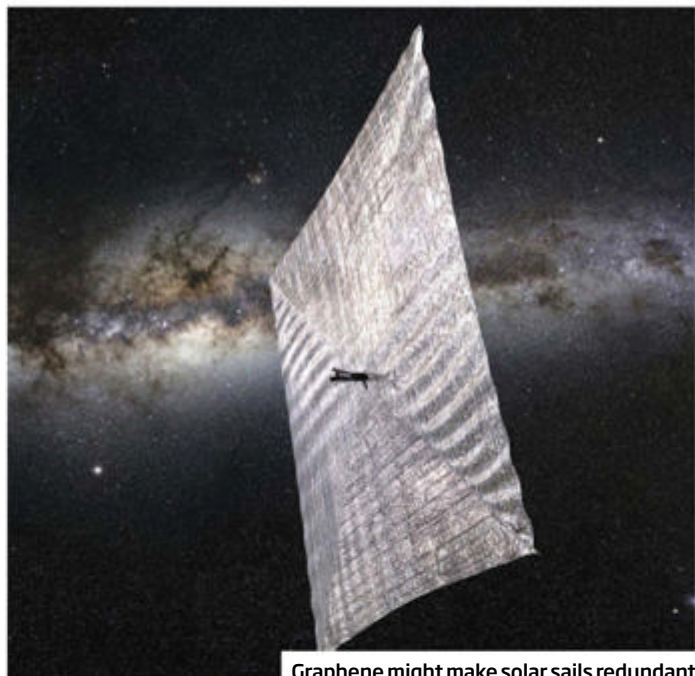
While cutting graphene sponge with a laser, they noticed the light propelled the material forwards. That was odd, because while lasers have been used to shove single molecules around, the sponge was a few centimetres across so should be too large to move.

The team placed pieces of graphene sponge in a vacuum and shot them with lasers of different wavelength and intensity. They were able to push sponge pieces upwards by as much as 40 centimetres. They even got the graphene to move by focusing ordinary sunlight on it with a lens.

But how was this movement happening? One explanation is that the material acts like a solar sail. Photons can transfer momentum to an object and propel it forwards, and in the vacuum of space this tiny effect can build up enough thrust to move a spacecraft. Just last week, the Planetary Society in Pasadena, California, launched a small solar sail to test the technology. But the forces the team saw were too large to come from photons alone.

The team also ruled out the idea that the laser vaporises some of the graphene and makes it spit out carbon atoms.

Instead, they think the graphene absorbs laser energy and builds up a charge of electrons. Eventually it can't hold any more, and extra electrons are released, pushing



Graphene might make solar sails redundant

the sponge in the opposite direction. Although it's not clear why the electrons don't fly off randomly, the team was able to confirm a current flowing away from the graphene as it was exposed to a laser, suggesting this hypothesis is correct ([arxiv.org/abs/1505.04254](https://arxiv.org/abs/1505.04254)).

Graphene sponge could be used to make a light-powered propulsion system for spacecraft that would beat solar sails. “While the propulsion force is still

smaller than conventional chemical rockets, it is already several orders larger than that from light pressure,” they write.

“The best possible rocket is one that doesn't need any fuel,” says Paulo Lozano of the Massachusetts Institute of Technology. He thinks a graphene-powered spacecraft is an interesting idea, but losing electrons would mean the craft builds up a positive charge that would need to be neutralised, or it could cause damage. ■

## Paws for thought on dog-wolf split

MAN'S best friend may be a very old friend indeed. An analysis of a bone from a newly identified ancient wolf species suggests that dogs may have split from wolves as early as 40,000 years ago.

The dates when dogs started to be domesticated and became a different species from wolves are a matter of some controversy. Archaeological evidence from dog-like skulls found near early human camps suggests it

might have happened as far back as 35,000 years ago. DNA analysis, focusing on differences between the genomes of living dogs and wolves, suggests a more recent split – between 11,000 and 16,000 years ago.

Now Love Dalén from the Swedish Museum of Natural History in Stockholm and his colleagues have sequenced the genome of a wolf that lived 35,000 years ago in Taimyr, Siberia. This allowed them to recalibrate the rate at which genetic differences have accumulated over time and better reconstruct the evolutionary tree. They found that dogs and wolves must have split into

different lineages between 27,000 and 40,000 years ago, bringing the DNA and archaeological evidence into line (*Current Biology*, [doi.org/10.1016/j.cub.2015.04.025](https://doi.org/10.1016/j.cub.2015.04.025)).

“Early modern humans might have been so resourceful that they started making use of dogs during the height of the last ice age,” says Dalén.

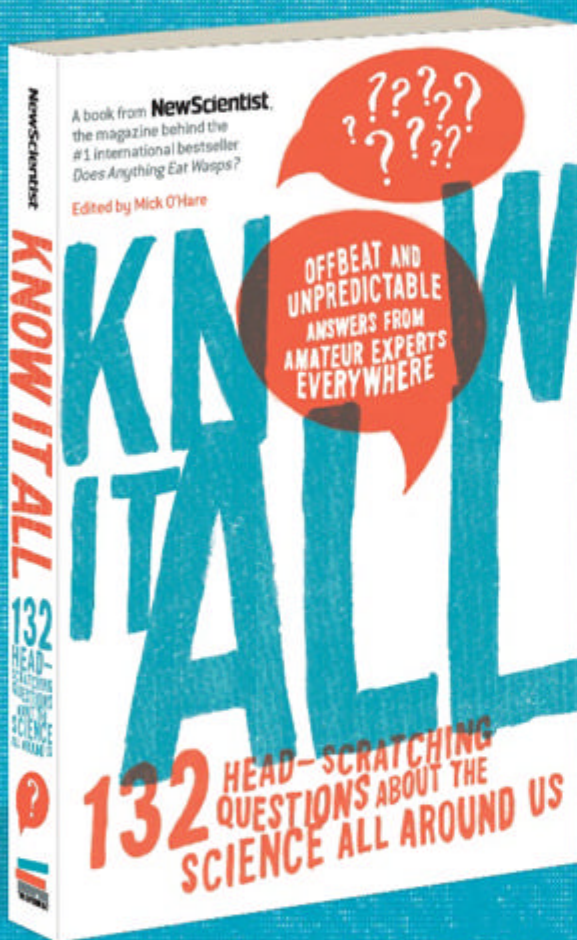
Even though the findings back an early split of dogs from wolves, they don't tell us for sure when the domestication of dogs started. “The present study does not rule out the

possibility of a very early date indeed, but it does not rule the possibility of a much later date either,” says Laurent Frantz from the University of Oxford.

Perhaps the split was not due to domestication: another possibility is that there was an early split between two types of wolves, and dogs emerged later from one of the lineages. “We do not yet know whether it infers an early divergence between two wolf populations or between wolves and dogs,” says Frantz. More genomic and morphological work on ancient wolf or dog specimens is needed before we have a conclusive date on the time of domestication, says Dalén. Michael Slezak ■



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Most people find ways to cope

## A pill to protect against stress?

Jessica Hamzelou

IF YOU knew you were about to go through a stressful experience, would you pop a pill to protect yourself from its knock-on effects? It's an idea that has been mooted after a drug seemed to make mice immune to the negative impacts of stressful events. But could we rationalise prescribing such a drug?

We all experience stress during our lives, whether it be a one-off event, such as a loved one dying, or chronic, low-level stress that results from struggling to make ends meet, for example. While most people find ways to cope, for some a particularly stressful event can trigger depression.

What if there was a way to boost our stress resilience and thus shield us from depression? Rebecca Brachman at Columbia University in New York stumbled across the idea while she was giving ketamine to mice with the symptoms of depression.

Even though the ketamine-

taking mice had been chronically stressed, when they were dropped in a pool of water – a one-off stressful event – they were unperturbed and swam to an exit. Mice not given the drug made no attempt to escape, a classic sign of depression in rodents.

There was also no change in the ketamine-taking animals' cognitive abilities or metabolism – both of which are altered in human depression. "It's really remarkable," says Brachman. "They basically look like mice that haven't been stressed."

A single dose of ketamine protected mice from developing the symptoms of depression after stressful events for four weeks. But the drug only seemed to stop the symptoms of depression – some of the animals still exhibited anxiety behaviours. "It seems to protect against depression rather than anxiety," says Brachman, who controversially describes it as a depression "vaccine". The work will be published in *Biological Psychiatry*.

If the findings translate to humans, the idea that ketamine could protect us from depression after stressful events is very exciting, says Gerard Sanacora at Yale University.

The drug's usefulness will depend on how long the effects last, and how well you can predict whether someone's life is about to get really stressful, says Brachman. "It could be useful for soldiers, or people working in natural disaster environments," she says. Sanacora adds that it might also be useful for people who have just been diagnosed with a chronic illness.

But not everyone is convinced. Military personnel currently receive psychological training

**"If you could find people who were vulnerable and protect them, that would be very useful"**

to boost their resilience, but all approaches are experimental, and none has been shown to be particularly effective, says Charles Figley, a trauma psychologist at Tulane University in New Orleans, Louisiana.

And even if we could protect someone from the effects of stress, we might not want to, he

says. Stress is a normal part of most people's lives, and can even be beneficial in some cases. Children who have dealt with stressful experiences tend to be better at dealing with stress later in life, says Figley. "The concern is that we're medicalising normal behaviour."

Figley thinks that if a drug were available, it would be almost impossible to know who to give it to. Ian Anderson, a psychiatrist at the University of Manchester, UK, agrees. He points out that debates rage over whether to treat teenagers who show the vague behaviour changes that precede the delusions and hallucinations of schizophrenia. Many who have these symptoms don't develop schizophrenia, so doctors are divided on whether they should be treated with drugs.

"If you knew someone was going into a very stressful situation, if you could find people who were vulnerable and protect them, that would be very useful," says Anderson. "But you'd have to be selective – you couldn't just give it to anyone willy-nilly."

Then there's the use of ketamine – a well-known party drug – itself. Ketamine has been used as an anaesthetic since the 1960s, and has recently been explored as an antidepressant. Most existing drugs take weeks to act, whereas ketamine gives rapid results. It does, however, have downsides: it can bring on hallucinations, and chronic use can damage the brain and bladder.

Because the idea behind it as a way to build resilience to stress is to only take it sporadically, in anticipation of stressful events, you would only experience the drug's negative effects for a few hours, says Brachman.

Ketamine is clinically approved as an anaesthetic so could be used as soon as it is proven to work in people, she says. While Brachman plans to start testing this, she says she will also look for other drugs with similar effects but without the downsides. ■





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**NewScientist**

# Avoiding war over Ethiopia's Nile dam

Fred Pearce

CRISIS averted? Scientists may be on the verge of resolving a potentially war-triggering water dispute: how to share out the flow of the River Nile. A decades-long row over one of the world's longest rivers pits downstream Egypt, whose agriculture depends on the

river's flow, against upstream Ethiopia, which is building Africa's biggest hydroelectric dam.

There have been threats of war over the \$5-billion dam, but researchers hope they have come up with the bones of a win-win deal that gives more water and electricity to both countries. They are now pressing for its inclusion

in a final deal on the dam to be signed next year.

Ethiopia began construction of the Grand Ethiopian Renaissance Dam in a gorge of the Blue Nile, the Nile's biggest tributary, in 2011 and expects to have it up and running in 2017. The dam will be able to hold back the entire flow of the Blue Nile for more than a year, potentially cutting supplies to Egypt and Sudan (see map, right).

But on 23 March, the three governments announced a surprise preliminary agreement to share the water. Behind the move was an optimistic assessment by international hydrologists and engineers, which has now been made public.

The solution involves reducing the losses to evaporation from Lake Nasser, the reservoir behind Egypt's Aswan High Dam in the Nubian desert. Up to 16 cubic kilometres of water evaporate annually from its surface – a quarter of the Nile's average flow and up to 40 per cent in a dry year.

Storing more of that water in the reservoir behind Ethiopia's dam could cut those losses, as it is deeper, has a surface area less than a third as great and sits in the cool and wet highlands. But it would also cut Egypt's electricity generation, so Ethiopia would need to share electricity from its new dam, says Kenneth Strzepek at the Massachusetts Institute of Technology.

## Taming the Nile

Construction of Ethiopia's dam has led to threats of war, but it could actually benefit Egypt by cutting water loss from Lake Nasser



Sudan, too, could benefit from the dam and a more even water flow, reducing the risk of flooding and increasing the potential for irrigation. "The government of Sudan is already selling land leases for new farmland by the river," says Alex de Waal of the World Peace Foundation at Tufts University in Boston. ■



Good for Ethiopia, good for Egypt

## The dinosaur that laid blue-green eggs

THE American robin's egg lends its name to a striking shade of blue, but the hue may have been colouring eggs long before the bird evolved – perhaps before any birds evolved. It may have been the colour of their dinosaur ancestors' eggs 150 million years ago.

Ornithologists once assumed early birds – and dinosaurs – laid white eggs. But some of the most ancient groups

of birds still around, including the tinamou and emu, lay coloured eggs.

Mark Hauber at Hunter College in New York and his colleagues discovered that the colour of many birds' eggs comes from the way that two pigments in the shell – biliverdin and protoporphyrin – blend with each other and with the calcium carbonate that makes most of the shell (*Biology Letters*, doi.org/4sp).

But when did eggs first get the two pigments? Martin Sander of Bonn University in Germany has an idea. In a separate study, he and his team looked at eggs from prehistoric sites

in China where *Oviraptor* dinosaurs laid their eggs millions of years ago.

The team chose the site because the eggs there are very pale. Dinosaur eggs found elsewhere are typically deep brown or black as minerals have seeped in over time and stained them, obscuring pigment molecules in the shell. Team member Jasmina Wiemann found the *Oviraptor* eggs contained biliverdin

**"The dinosaurs incubated their eggs in open nests, so coloured eggs would be camouflaged"**

and protoporphyrin in a ratio suggesting they were blue-green (PeerJ Preprint, DOI: 10.7287/peerj.preprints.1080v1).

"This is our first knowledge of anything about dinosaur egg colours," says David Varricchio, who studies dinosaur biology at Montana State University.

The similarity to modern birds probably reflects similarity in lifestyle, says Sander. The Chinese dinosaurs incubated their eggs in open nests, rather than burying them. Coloured eggs would be camouflaged from predators. Jeff Hecht ■



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## Thousands of new plankton revealed by giant sea survey

IT'S the world's largest ecosystem, producing half of all the oxygen that comes from photosynthesis – but we know very little about the ocean's microscopic plankton.

Data collected by researchers on the schooner Tara are starting to change that. Between 2009 and 2013, the ship sailed the world's seas and oceans, collecting 35,000 plankton samples from the upper layers of the water. Its first batch of studies was published this month, revealing plankton's great diversity. We already knew of about 4350 species of microalgae, 1350 species of protists and 5500 species of tiny animals, based on studies of their

appearance. But the new genetic evidence says there are probably three to eight times as many distinct species in each group (*Science*, DOI: 10.1126/science.1261605).

And the ocean's microbial community has some striking similarities to the community inside our guts. The two occupy very different environments, but they have an almost identical abundance of genes involved in replication, ion transport and cell motility (*Science*, DOI: 10.1126/science.1261359). "This certainly was rather a big surprise because we expected different ecosystems would have microbial communities with functions that would be completely different," says Shinichi Sunagawa of the European Molecular Biology Laboratory in Heidelberg, Germany, whose team catalogued and analysed the microbial plankton genes from the Tara.

## Solar threads will energise your look

WE OUGHT to take a leaf out of their book. Trees are basically clad in solar cells, and soon we could be doing the same using energy-harvesting fabrics.

Qingwen Li from the Chinese Academy of Sciences in Suzhou and colleagues wanted to exploit a new type of solar cell made of a mineral called perovskite. Flat versions of these cells are able to convert 20 per cent of the energy

in sunlight into electricity. They can also be made 400 times thinner than conventional silicon cells – so thin that they are bendy.

To put the cells into weavable threads, the team coated carbon nanotubes in several layers of material, including the crucial perovskite, silver to increase the conductivity, and a protective transparent film.

When woven into cloth, the

fibre converts about 3 per cent of the solar energy hitting it into electricity – a far cry from the flat sheets, although Li says this can be improved (*Advanced Materials*, doi.org/f272zw).

Perovskite-infused clothes could be ideal as chargers for the wearable tech gadgets that seem to surface every week. The main problem to solve is that contact with air and moisture currently causes the cloth to stop producing electricity after just four days.

## A tastier way to clean out bowels

PREPARING for a colonoscopy doesn't have to be a pain in the backside. A special menu could save people the discomfort of fasting and drinking litres of foul-tasting fluid.

A day-long course of specially prepared food containing laxatives and electrolytes can clean the bowel just as well, says L. Campbell Levy of the Dartmouth-Hitchcock Medical Center in Lebanon, New Hampshire.

Levy told the Digestive Disease Week conference in Washington DC that a pilot study met its objectives in terms of persuading people to consume the foods after only 10 of the anticipated 30 patients had tested the method.

Only 58 per cent of people in the US between the ages of 50 and 75 are regularly screened for colon cancer. Unpleasant fasting puts others off. It is hoped that the new menu, which could be available by 2017, will boost participation.

## Early human was Lucy's neighbour

LUCY wasn't the only type of early human in her neighbourhood about 3.2 million years ago.

Yohannes Haile-Selassie of the Cleveland Museum of Natural History in Ohio and his team have discovered a species they call *Australopithecus deyiremeda*. It lived in the central Afar region of the East African Great Rift Valley about 3.3 million years ago, just 35 kilometres north of a known site of *Australopithecus afarensis*, Lucy's species (*Nature*, DOI: 10.1038/nature14448).

Haile-Selassie says they also found *A. afarensis* specimens at their site, so the two species overlapped. "They probably fought for resources. However it is difficult to find out whether they hunted each other or interbred."



## Chat to possums to save them

HOW do you locate small, shy and speedy possums that hang out at the top of the tallest trees? You talk to them, of course.

Leadbeater's or fairy possums (*Gymnobelideus leadbeateri*) are critically endangered and only a few thousand remain, in a small stretch of swampy forest north-east of Melbourne, Australia.

Their population at one site, the Yellingbo Nature Conservation Reserve, has declined by more than 60 per cent over the past decade and now numbers just 40 individuals, says Dan Harley at Zoos Victoria in Melbourne. "Severe deterioration in habitat conditions has driven the decline."

Knowing how many possums are left is crucial to determining if conservation measures are working, he says. Checking the nest boxes supplied for the possums to live in isn't enough. If they're not in, it is hard to know if the family has moved to a new nest, left the area – or worse. So, Harley tried using the possum's own chattering call. He found they often approach and replied to his efforts (*Australian Mammalogy*, doi.org/4rx).

The technique isn't perfect, says Harley, but it could complement other counting methods. There are false negatives: 31 per cent of his calls didn't elicit responses, despite him seeing a possum nearby.



## Vesta has no moons - is it unlucky or did it eat them?

THE biggest asteroids are loners. A decades-long search for moons orbiting Vesta, the second-heaviest object in the asteroid belt, has come up fruitless, raising questions about how such massive rocks remain alone.

Nearly 100 main-belt asteroids have satellites, most of which were found without a dedicated search. But although we have looked for moons around Vesta since 1987, none has turned up.

Finding and studying one could give insight into Vesta's orbital stability and the evolution of the

solar system, because any moon would be a physical record of its past.

So when NASA's Dawn spacecraft approached Vesta in 2011, "we couldn't pass the opportunity to look one more time", says Lucy McFadden of NASA's Goddard Space Flight Center in Greenbelt, Maryland.

McFadden and her colleagues analysed close-up images of Vesta's environment collected over three months in 2011 and 2012, finding no trace of any companion object larger than 6 metres wide

(*Icarus*, doi.org/4r6).

The lack of moons is puzzling, especially given Vesta's two huge impact craters, which are the source of a family of asteroids. "Those impacts should have produced a lot of debris that should have been very good at forming satellites," says William Bottke of the Southwest Research Institute in Boulder, Colorado.

Nick Gorkavyi at NASA Goddard has another idea: moons existed, but crashed into Vesta long ago, digging huge canyons such as the enigmatic Divalia Fossa.

## Spider's amorous song lures mates

THEY don't have ears but they still sing. For the first time, a spider has been recorded making what appears to be an audible courtship signal – a sort of a soft purr.

"It's very quiet, but it's what you would hear if you were in the room with a courting spider," says George Uetz of the University of Cincinnati in Ohio, who described the work last week at a meeting of the Acoustical Society of America in Pittsburgh, Pennsylvania.

Many spider species shake leaves or strands of their webs, creating vibrations that nearby spiders feel directly. But Uetz and his colleague Alexander Sweger showed that male purring wolf spiders (*Gladicosa gulosa*) vibrate dead leaves to create an audible thrumming sound. Only females respond to a recording of it, suggesting it is used in courtship.

Uetz and Sweger think that females pick up on the sound indirectly, when it causes the leaves they are standing on to vibrate. "We think that's how she 'hears' the sound," says Sweger. He says the findings suggest that animals could have used vibrations as a stepping stone in evolving the ability to communicate acoustically.



## Awesome views make you... awesome

SELF-help gurus extol the benefits of "awakening the giant within" – but don't dismiss the benefits of feeling small. A diminished sense of self-importance caused by feeling awe can make people more considerate and generous.

Paul Piff of the University of California, Irvine, and his colleagues instilled a sense of awe in a group of volunteers by asking them to spend 60 seconds staring up at a grove of 60-metre-tall Tasmanian eucalyptus trees. A control group stared up at a less awe-inspiring building. The researchers then staged an accident,

dropping a box of pens. The group that had gazed at the trees were more helpful and picked up more pens.

Further studies involving the tree-gazing exercise showed that awe also encourages people to endorse more ethical decisions and lower their sense of entitlement (*Journal of Personality and Social Psychology*, doi.org/4r5).

"No matter who you are, awe has that effect," says Piff – but many of us are unaware of the fact. "We're in the midst of an awe deficit. People are prioritising other things."

## INSIGHT Law enforcement



MARK HANDEL/GETTY

Tension instead of trust

# Policing the police

The relationship between law enforcers and the communities they protect is broken. **Aviva Rutkin** looks at using data to restore the trust

CAMDEN, New Jersey, isn't where you might expect to find the future of policing emerging. It was renowned as one of the most violent cities in the US for decades. Two years ago, struggling with crime and running out of money, the city scrapped its police department entirely.

But now Camden is at the centre of an ambitious new scheme. The White House launched the Police Data Initiative there last week, tasking Camden and 20 other US cities with using data analysis to understand and change police behaviour in an attempt to heal the broken relationship between them and the public.

The move follows a wave of police brutality in the US (see "A year of violence", right) and the establishment of the Task Force on 21st Century Policing, formed by Obama in December. The first report from the task force, published on the day of Obama's Police Data Initiative, stressed the importance of collecting, sharing

and scrutinising such data. It recommended examining department policies, incidents of alleged misconduct, recent stops and arrests and the demographics of officers. Analysing the data, the authors write, is vital "to knowing what works and what does not work, which policing practices are effective and which ones have unintended consequences".

## A YEAR OF VIOLENCE

The number of deaths of US citizens at the hands of police officers has made for a troubling trend over the past year. Eric Garner died repeating "I can't breathe" while an officer kept him in a chokehold. Twelve-year-old Tamir Rice was killed by the police officers while playing with a BB gun in the park. Jason Harrison, a mentally ill man, was shot when he failed to drop a screwdriver. And Michael Brown, 18, was shot and killed by a police officer on the streets of Ferguson, Missouri.

Some police departments are already putting their data to work. This summer, the University of Chicago's Data Science for Social Good programme will start building an early warning system for local police departments. The algorithm will scour police data and pick out problematic officers, tagging them for further training or intervention.

In light of this, Obama formed the Task Force on 21st Century Policing in December, to "examine how to strengthen public trust and foster strong relationships between local law enforcement and the communities that they protect".

Meanwhile, deaths at the hands of police have continued to make the news – most notably last month, when 25-year-old Freddie Gray suffered a fatal spinal cord injury while restrained in a police van in Baltimore, Maryland.

Similar systems exist in other parts of the country, but the White House warns that those may not be effective, because there has been little research into which factors most strongly predict a problem. The Chicago pilot will be grounded in such research.

Rayid Ghani, who heads up

**"The community, rather than the police, can analyse that data and hold the officers accountable"**

the Data Science for Social Good programme, says systems like this can help prevent problems from happening. "It really changes the way a lot of government agencies work. Today, they're purely reactive, but now they can be much more proactive," he says.

Strategies such as predictive policing already use data analytics to try to prevent crime. Now, those same techniques are being applied to the police themselves, trying to pre-empt the possibility of brutality.

On-body cameras may provide a rich source of data. The cameras, which have been shown to reduce the use of force and the number of complaints from citizens, have been adopted by about one-third of police departments across the country. The Department of Justice now plans to spend \$20 million on acquiring more. In Oakland, where officers have been required to wear cameras for the past four years, researchers at Stanford University are developing tools that can automatically detect positive or negative interactions from the audio in a recording.

It's clear that the potential is great, but there's a long road ahead. William Terrill of Michigan State University in East Lansing sees a parallel with community policing, an approach that attracted attention after the civil unrest of the late 1960s. While the idea was warmly discussed, he says, there is marginal evidence that it was ever implemented



effectively. A few decades down the road, we could be saying the same about these data-driven strategies.

“Police departments are good at making reactionary policies in times of crisis, but not making substantive changes,” Ghani says. “My greater fear is that things will calm down and police departments will go back to the same old, same old.”

To address that problem, cities involved in the Police Data Initiative have promised to release statistics about hot-button topics like vehicle stops and officer-involved shootings. And non-profit Code for America is building software to make it easier for agencies to open up.

The idea is that the community, rather than the police themselves, can analyse that data and hold the officers accountable for their actions. “People want to know and understand what’s happening in their own communities. They actually want to see the data, to be able to analyse it in their own ways,” says Robin Engel of the University of Cincinnati in Ohio.

This isn’t the only aspect of policing that needs overhauling. Terrill says the Obama initiative may encourage a long overdue record-keeping upgrade. A typical police department’s data is disorganised, with separate systems to track things like 911 calls, internal affairs and officer training. This disorganisation means that there is no common metric to compare different police departments, and it can be difficult or impossible to measure performance in areas like reducing use of force.

The ability to compare the performance of different police departments is crucial because it incentivises change and improvement. Terrell says the picture would look very different if existing US police departments operated in a more competitive, transparent environment: “They would have gone out of business years ago.” ■

## Machines are in training to be concert virtuosos

FEW things can move us quite like a maestro on the violin. Could a computer soon be able to twist our feelings in the same way, by learning musicians’ best tricks?

Prolody, a start-up based in the Netherlands, is pioneering a new approach to synthesised music that emulates the richness of analogue instruments and the sensitivity of human players. Unlike the flat jangle that often typifies synthetic tones, Prolody’s sounds are full and alive because they make use of human-produced notes. Its system is setting the scene for beautiful music that is played by a machine with its own aesthetic sense.

The team started with the violin – a notoriously difficult instrument to synthesise. They got a human violinist to play tens of thousands of notes and phrases in the studio, encompassing loud and soft, bright and mellow, trembling and majestic. The goal was to capture as much expressiveness as possible, for a computer to digest and process into a system capable of mimicking that expressiveness.

Creating libraries of sound samples in this way is not new, but Prolody has

a twist. “We’re not just recording single notes, we’re paying attention to context,” says the firm’s co-founder, Dennis Braunsdorf. The company has built a machine-readable database from those thousands of samples, tagged with the musical context in which they were played, paying special attention to how notes sound in sequence.

When rendering music using these samples, the computer chooses the note or sound that best meshes with the rest of the piece. The goal is a rendition which sounds more natural than anything existing synthesisers

**“This is setting the scene for beautiful music played by a machine with its own aesthetic sense”**

can produce. Prolody is already in talks to license its system to a music software developer, and plans to repeat the process for other instruments.

The new sound impresses Julian Gregory, a first violinist with the BBC Philharmonic Orchestra in Salford, UK. Traditional synthesisers have trouble

with smooth transitions between notes. “The connections between notes are really important and that’s vastly improved here,” Gregory says.

Prolody’s output still isn’t indistinguishable from a human performance, says Trevor Cox at the University of Salford. But with synthesised music already in use in theatrical shows and elsewhere, any improvements will enhance many performances and create new avenues for it, says Gregory. Cox points to corporate videos and video games as potential applications.

As well as teaching machines to make authentic sounds, Braunsdorf wants them to learn to perform. He is creating another database of the diverse ways in which musicians interpret a melody. He plans to apply machine-learning algorithms to this data so that a computer can acquire the ability to perform its own interpretation of a score.

Cox sees the potential for such a system. “A lot of pop acts play recorded material and perform live with it,” he says, but one problem is that is the backing track can’t alter according to the audience’s reaction.

A giggling computer which could produce its own take on the musical score at every performance could make that a thing of the past. It looks like the days of soulless muzak are numbered. Chris Baraniuk ■



AI is adding strings to its bow

SHONEDONATI/TERRA PROJECT/CONTRASTO/EYE/VEINE

# Radio in a bucket

Bare-bones broadcasts are setting information free in rural Uganda



Tub technology

JANE ADONG used to ride for 10 hours on a motorcycle to get to her nearest radio station. From there, she would broadcast her show – an advice segment dealing with HIV education. Her neighbours back in the Ugandan town of Patongo would tune in and listen.

This week, she got those hours back. Adong and the NGO she founded, Gwokke Keni, now have a station of their own in Patongo, one of four prototype radio transmitters being erected in rural Ugandan towns and villages. Made from a bucket, some circuitry and a smartphone, the system is opening up information access like never before.

Although the internet and social networks have revolutionised the rich world, millions of people in poor countries don't even have radio broadcasts in their own language. Traditional radio stations need a building with sound equipment that links to a powerful antenna. But as advances in electronics have driven computation into smaller and cheaper packages,

it has become possible to run a whole radio station with little more than a phone.

The stations are the product of RootIO, a start-up founded by Ugandan telecom expert Jude Mukundane and Chris Csikszentmihályi, formerly of the MIT Media Lab. Each consists of a solar panel, battery, 15-metre-tall transmitter tower and a smartphone. A white 19-litre bucket houses the hardware and keeps it dry.

The smartphone is the linchpin. It runs an Android app that

connects to radio hosts' personal phones, letting them control the broadcast through a phone call and their standard keypad. Smartphones at each station can talk to each other through the app to syndicate content, but most initial programming will serve specific local needs. In one show, listeners will call in with the vocal equivalent of classified

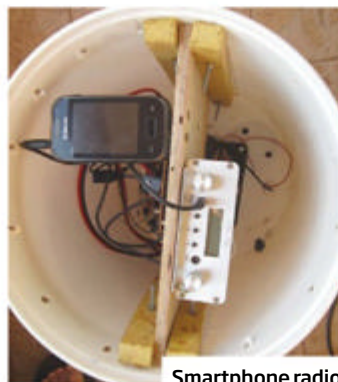
**"It has become possible to run a whole radio station with nothing more than a phone"**

listings – a valuable service in places like rural Uganda, where literacy rates are low.

Another will have an advice segment that focuses on veterinary and agricultural issues. Adong and Gwokke Keni will devote airtime to HIV destigmatisation and information on compliance with antiretroviral medication. Because cellphones are plentiful in Uganda but minutes of talk time are not, RootIO's system will register the caller's telephone number for all call-in shows and, instead of connecting, will hang up and dial the person back at no charge.

"[It] provides an interconnection between radio and phone, two of the most pervasive technologies used by poor and marginalised people," says UNICEF's Sharad Sapra. The result is a radio that functions more like a telephone, designed for a two-sided conversation.

Silicon Valley technology is often touted as a way to better the lives of people in poor countries. But with her new station, and more like it coming soon, Adong and other Ugandans are taking the power of information into their own hands. **Luke Yoquinto** ■



Smartphone radio



## Oxygen into wine

*In vino veritas*, they say, but you find more than truth in a good glass of red. Oxygen, in just the right amount, is crucial. The air-tight steel barrels often used for ageing make it difficult and expensive to ensure a wine gets enough. Now New Zealand entrepreneurs have created the "wine grenade" – a small, cheap gadget that can be plunked into the tank to gradually release a specific amount of oxygen, making sure your red is perfectly aerated.

# 970

The thickness in micrometres of a screen made by Korean electronics company LG – so thin you can stick it to the wall with a weak magnet

## Algorithmically racist

Two tech giants faced public outcry over embarrassing bugs this week. Searching a racial slur on Google Maps sent users to the White House. Meanwhile, Flickr's automated image tagging had been labelling pictures of black people with the words "ape" and "animal", and pictures of Dachau concentration camp with "jungle gym". Both companies apologised and pledged to fix the issues.



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## Melting moments

Going...going... thousands of years of frozen history will be gone in a matter of decades. The hole in the centre of this ice-filled cave in central Austria is growing quickly, swollen by the warming climate. With the melting ice, unique climate records are trickling away - before we can figure out how to interpret them properly.

The ice in these deposits is special because it promises to unlock secrets about past climate other natural archives won't easily relinquish.

Unlike ice cores - which offer incredibly detailed and ancient records of the climate - the cave ice could spill the beans on more recent atmospheric conditions in heavily inhabited areas, says Marc Luetscher from the University of Innsbruck, who is working on the ice. What's more, the ice would neatly complement tree-ring records. Trees grow faster during warm weather, so give good information about climatic conditions in summer. The ice in the caves forms during cold weather, telling us what winters were like.

Luetscher says that to interpret the data, they need to figure out exactly how the ice hung around despite historic mean annual temperatures that were frequently above 0 °C.

The rare large ice crystals in the picture below - which come from a nearby cave - might offer some clues, says Luetscher, because they grew very slowly and so preserve a precise record of temperature fluctuations in the region.

Michael Slezak



### Photographer

**Robbie Shone**

National Geographic Creative

# We are not amused

Prince Charles's pleas to ministers over complementary medicine have at last been made public. About time, says **Edzard Ernst**

THE "black spider" letters finally scuttled into the open this month. After a long battle by newspaper *The Guardian*, correspondence from Prince Charles, heir to the British throne, to UK government ministers was made public.

Charles had been suspected of attempting to influence political decisions. In the 27 letters, written in 2004 and 2005, he expressed disquiet at, among other things, moves to bring herbal medicines and acupuncture under increased scrutiny and regulation.

We may never get to see other letters he wrote, but Charles has made no secret of his support for many aspects of complementary medicine, including perhaps the most controversial – homeopathy.

Despite the absence of any evidence of effectiveness, it is still possible to obtain homeopathic treatment on the UK's National Health Service. Yet five years ago,



an official report concluded that the NHS should stop the funding of homeopathy. What happened? Nothing. Politicians said that patient choice trumps science, and rumour had it that Charles had something to do with this absurd outcome.

Homeopathy flies in the face of science and evidence-based medicine. Its practitioners believe that "like cures like". A common example is onion: it makes eyes water, so is used to treat conditions such as hay fever. Homeopaths do not use pure onion: instead, they repeatedly dilute remedies while shaking them, a process they call "potentisation". They believe this makes remedies more powerful, not weaker. Thus typical remedies are devoid of even a single active molecule.

Unsurprisingly, all the reliable evidence from clinical trials shows homeopathic remedies are no

## Time to tame a killer

The US is tightening the screw on trans fats in food. It's a welcome move, says **Oliver Tickell**

TRANS fats are poised to be all but banned from food in the US. That is good news, and not just for Americans. It sends a strong message to the UK and other countries that lack regulation, despite overwhelming evidence that industrial trans fats raise the risk of heart disease and strokes.

Admittedly, these fats present

a challenge to regulators, but not enough to prevent action that could stop many early deaths.

Chemically speaking, they are types of unsaturated fatty acid. Such fats occur in two structural forms – known as *cis* and *trans* – that affect their properties. Trans fats, which are a broad family, tend to be solid at room

temperature, more akin to saturated fats. Some are bad for you, others are harmless, and one is beneficial – vaccenic acid in milk, butter, cream and cheese. Indeed, trans fats are in all fats from ruminants, but there doesn't seem to be a link between natural versions and ill health.

Health problems only arise from those made industrially, for example by partial hydrogenation of unsaturated oil. The resulting oil – often cited as "hydrogenated

vegetable oil" – pretty much vanished from packaged-food ingredient lists as evidence of ill effects grew. Effectively banning this oil from all food, as the US looks set to do, would tackle any exceptions to this trend. Fortunately, industrial and natural trans fats can easily be told apart.

But there are complications. Industrial trans fats can also form during the cleaning and refining of polyunsaturated oils at raised temperatures. The hotter the plant runs, and the longer the oil is heated, the more trans fat is produced. In a well-run plant, this can be kept to 1 per cent. But in a badly run one, it could reach an

**"There is overwhelming evidence that industrial trans fats raise the risk of heart disease and strokes"**



more effective than placebos.

Beyond the UK, health bodies are acting on this evidence. The Australian National Health and Medical Research Council recently released the most comprehensive, rigorous and open assessment of homeopathy. It concluded that it should not be used for conditions that are chronic, serious, or could become serious. "People who choose homeopathy may put their health at risk if they reject or delay treatments for which there is good evidence for safety and effectiveness," it said.

The US Food and Drug Administration looks set to follow suit. It announced a public hearing on homeopathic products and regulation, which is likely to confirm the Australian verdict.

Given a history of defending the indefensible, and the growing actions elsewhere, it seems all the more important that the UK takes action on complementary medicine based on evidence. We should not allow anti-scientific points of view to hold sway, no matter where they come from. ■

Edzard Ernst is a professor of medicine who pioneered scientific scrutiny of complementary therapies. His latest book is *A Scientist in Wonderland: A memoir of searching for truth and finding trouble* (Imprint Academic)

unacceptably high 5 per cent. For many consumers, this is probably now the main source of industrial trans fats. So regulators should make sure that all oil processors achieve very low levels of them. Ultimately, we need to find out which specific trans fats cause serious health damage, so we can address them directly. As ever, more research is needed.

Still, we know quite enough to begin regulating industrial trans fats right now, improving the nation's health and preventing countless premature deaths. ■

Oliver Tickell is a science journalist and health campaigner in the UK

## ONE MINUTE INTERVIEW

# 3D print a home on Mars

When NASA sends astronauts to the Red Planet, they may 3D print their base on arrival – with your help, says **Sam Ortega**



### PROFILE

Sam Ortega is a systems engineer who manages NASA's Centennial Challenges, which encourage creative people everywhere to develop novel aerospace technology. He is based at the Marshall Space Flight Center in Huntsville, Alabama

### What is NASA's 3D Printed Habitat Challenge?

To put humans on Mars, NASA is going to need new technologies. The challenge aims to tap unconventional sources to create that tech: we're reaching out to makers, hackers, innovators, artists, scientists, hobbyists, retirees – pretty much anybody – and offering several million-dollar prizes.

### What are you asking people to do?

Ultimately we want a 3D printer that we can send to Mars to build habitats for astronauts, using only the materials found on the planet's surface and recycled plastic. For NASA's human journey to Mars, expected in the 2030s, we must take everything that we need with us or use what's there – we call this "zero mass exploration".

As we fly out and the astronauts consume their food, the plastic packaging is left over, as is the packaging of various experiments. Once we get to Mars, we'll have an abundance of it. So one aspect of the challenge will be to combine plastic with regolith – Martian soil – and demonstrate

that you can print with these two materials. Another aspect is to 3D print an actual residence large enough to house four astronauts.

### How might this building material be made?

The plastic might be used as a glue or binding agent for the regolith. Or instead of heating and squirting materials like a conventional 3D printer, somebody might use a laser's heat to fuse the regolith itself, to solidify it, with plastic simply used as aggregate. Anything is possible. The really nice thing about the surface of Mars, and the moon, is that the rock and soil is already loose and in a condition to be used immediately – it's merely a matter of shovelling it up. For our challenge, we'll provide an analogue of this regolith.

### Shelter is one thing, but what about the other necessities people need to survive, such as oxygen and water?

People don't always realise this, but it's not so much that there's a lack of oxygen in a spacecraft or habitat, it's that you have too much carbon dioxide. So the issue is to scrub out the CO<sub>2</sub> and free the oxygen. Then there's water recycling. NASA's environmental control life-support systems focus mostly on water recycling, and so you always hear these stories of how NASA is recycling urine to drink. And, yes, we do that. But with zero mass exploration, you need to get 100 per cent recyclability, which means you can't afford to lose 2 per cent of your water by not extracting it from solid human waste. How do you get that water out? That's something we'll have to address for extended missions like a trip to Mars.

### Alien worlds aside, it's fair to say that lots of people need shelter on Earth...

Whenever we develop a new competition we try to make sure that there's an application here on Earth. We have plenty of waste plastics, and we have plenty of rocks we could crush up. If we can create technology to print with just plastic and rocks, imagine the possibilities. We could make anything from houses to doghouses.

**Interview by Sean O'Neill**

# The hydra effect is no myth

Kill off something and you end up with more of it? What is going on? Welcome to the paradoxical world of the hydra effect, says **Peter Abrams**

GARDENERS who apply insecticide do not expect pest populations to flourish. Nor do fishery regulators anticipate that more fishing will boost the size of their stocks. Perhaps they should.

Thanks to the complexity of the natural world, killing individuals doesn't always end up diminishing their population. The failure to consider this possibility could be confounding resource management and pest eradication, and perhaps even attempts to boost numbers of threatened species.

A decade ago, my collaborator Hiroyuki Matsuda and I coined the term hydra effect to describe all situations where a higher death rate in a particular species ultimately increases the size of its population. We named this phenomenon after the multi-headed serpent of Greek myth that grew two heads for each one that Hercules cut off. The hydra effect is just one example of a more general phenomenon where adverse changes in the environment that reduce the growth rate of a population may ultimately lead to greater numbers.

## Bounce back

What could cause populations of animals or plants to bounce back so strongly in spite of a continued higher death rate? When a population experiences increased mortality – due to, say, harvesting – the initial effect is almost always diminishing abundance. However, after this initial decline, other organisms they interact with are likely to change. In most cases the organisms they eat go up in abundance. Diseases and predators that depend on the harvested population decline. Also, a higher risk of death often

causes individuals to reduce their activity levels and to spend more time hiding, allowing their over-exploited food species to recover. Tadpoles in ponds with more predatory dragonfly larvae have been shown to end up getting more algae to eat, despite spending less time feeding. In a large food web many other complicated positive feedbacks exist.

Of course, a high enough death rate will always lead to extinction, but Matsuda and I showed that hydra effects can occur over a wide range of mortality rates. Some populations may even reach their maximum size when the death rate is only slightly lower than the rate that would guarantee extinction.

Although we didn't know it, experimental evidence for the hydra effect in a natural setting was emerging when our work was published. A group of biologists at Cornell University was then nearing the end of a seven-year project to remove an invasive fish species, smallmouth bass, from a lake in New York State. When Elise Zipkin and colleagues later analysed their results, they found that the number of bass had grown considerably, despite the removal of at least 47,000 fish. This highlights the importance of understanding population dynamics before attempting to eradicate an invader.

Similar results have now emerged in the lab for a handful of other animals, ranging from bean beetles, a common kitchen pest, to *Tetrahymena*, a protozoan commonly found in ponds. There is also tentative evidence of a hydra effect in at least one plant, garlic mustard, an invasive European weed that has been the subject of (often unsuccessful) eradication attempts in North America.

The notion of a hydra effect was older than

## PROFILE

Peter Abrams is emeritus professor of ecology and evolutionary biology. His research focuses on mathematical models of ecological and evolutionary processes

**Hercules had to use cunning to kill the Hydra – we will need similar skill in our world**

Matsuda and I thought; seminal fisheries scientist William Ricker noted the possibility back in 1954. The effect was even demonstrated that decade in the laboratory for populations of water fleas and blow flies. But the idea was forgotten and only resurfaced more than 40 years later.

Today, however, research on the topic is growing rapidly, driven by the increasing number of experimental examples, and by new models that have found hydra effects in a much wider variety of species and food webs than we imagined. Recent work I carried out with Michael Cortez shows that they are possible for species occupying any position in food webs containing two to four species. An earlier study by the late biologist Peter Yodzis of mathematical models of a number of larger,







well-studied food webs showed that 27 per cent of the 223 species in these webs could exhibit hydra effects.

But if they could, in theory, be common, why have we seen so little empirical evidence of hydra effects in the natural world? One reason is that few people have looked for them. You might imagine that the history of fisheries would contain examples. But most exploited fish populations have great natural variability, many are not counted accurately, and fishing is rarely constant for long enough to determine the effect of a particular amount of fishing on the population.

The little evidence there is mostly comes from lab studies of small freshwater fish or water flea species. There is no reason to think these groups are especially likely to

## FISHING FOR TROUBLE

"I don't know if it's true, but I hope it isn't."

This was the response of a fisheries biologist after I gave a talk about the hydra effect a decade ago. He was right to be concerned. If it were widely known that harvesting can potentially increase the size of fish stocks, fisheries quotas might have been raised too rapidly. Fishers may welcome the counter-intuitive idea that catching fish may bump up the population, but hydra effects are not yet predictable. And modelling shows that the harvest rate which maximises a fish population is surprisingly often only slightly smaller than that which results in a dramatic collapse or extinction.

exhibit hydra effects – it is just that they are convenient to study experimentally.

Top predators are likely candidates because their populations are not held in check by another predator. However, their large body size and long generation time makes population studies difficult. Even so, hydra effects may explain failed attempts to control alien predators that are devastating native species. One potential example is the Indo-Pacific lionfish that is overrunning Caribbean coral reefs despite efforts to control it. Another is the Burmese python in Florida Everglades that have increased rapidly over the past decade in spite of harvesting efforts.

At least some of these populations are likely to be cases where the numbers are rising in spite of, rather than because of, our attempts to eradicate. Nevertheless, hydra effects may also be contributing to some failures to shrink populations. If so, a high enough harvest rate will still eventually decrease the population, but for these two problem species we don't know how high is high enough.

## Opposite outcome

The theory underlying hydra effects also predicts other counter-intuitive outcomes. For example, a reduced death rate can *decrease* the size of a population. Even adding captive-raised individuals of an endangered species may paradoxically reduce its population size. More generally, any attempt to manipulate a population under the influence of the hydra effect, will usually produce the opposite of the desired outcome. And if a species experiencing a hydra effect evolves a trait such as a better metabolism or the ability to overcome an infection, there is a good chance that such individually beneficial changes will result in a decrease in its numbers.

Much of the work comes from theoretical models, so we don't yet know the impact in the real world. Can we find out? Controlled experiments in nature are tricky, so it will take a while to build up a true picture. The most serious implications are likely to be for fisheries (see "Fishing for trouble", left) and control of alien species and insect pests. But given the wide range of mechanisms that can bring out the hydra, we need to factor it into resource management and conservation efforts.

Just as Hercules had to be cunning to destroy the mythical Hydra, biologists will need a wide variety of methods, together with a better understanding of ecological relationships, to deal with the real-life version. ■

COLUMBIA PICTURES/RONALD GRANT ARCHIVE

# CAN YOU HAVE YOUR CAKE AND EAT IT?

Eat less and better, exercise more, stay off the booze, don't skimp on sleep, and live as virtuously and sustainably as possible. It's become a mantra for a good life – though most of us have trouble sticking to it.

But does that extra piece of charcuterie, that missed gym date (and the little white lie about it) or that cheap flight seeking sun and sangria mean you're a sinner? *New Scientist* investigates which guilty pleasures you can get away with... and which ones you can't







In reality it's not so easy to spot a liar

## LYING AND CHEATING

Whoever says honesty is the best policy is probably lying right there. Lying is a vital, smoothing part of the social fabric. We develop the skill young: most 3-year-olds will lie about not having peeked at a toy you told them not to look at. The average UK adult admits to lying 10 times a week – even if these tend to be little white lies, like inventing reasons for not answering a phone call.

These fibs are surprisingly easy to get away with. Contrary to popular opinion, there are no reliable “tells”, says Robert Feldman of the University of Massachusetts Amherst and author of *Liar: The truth about lying*. Shifty eyes or showing anxiety – behaviours commonly associated with lying – aren’t consistent indicators. And we are hopeless at detecting lies, for good reason. “Most of the time we assume that people are telling us the truth. It’s really cognitively exhausting to always be assessing whether other people are telling the truth or not,” says Feldman.

Even so, there are tricks we can learn. The best liars are “natural performers”, says Aldert Vrij, a psychologist at the University of Portsmouth, UK. They “naturally exhibit behaviours that observers associate with honesty, such as making eye contact, smiling and smooth speech lacking in ‘ums’ and ‘ers’, even when they are lying”, he says. Many successful liars also mask signs of thinking hard – and it seems

good-looking people are more likely to be believed when telling porkies.

As for taking lying to the next level – from creating Ponzi schemes to leading a double life – complex deceptions might be easier than you would imagine, Feldman says. Keeping secrets is part of being human, and we are adept at compartmentalising our lives, for instance having different personas at work and at home.

## THE CLINTON EFFECT

Since telling white lies is so common, higher-level deception can become habitual for many people, says Feldman: “Think about all those people who are lying to their spouse, mostly by omission, and getting away with it.” And when a major deception is found out, some people manage to get off lightly – especially if they never came across as a paragon of virtue anyway. A good case study might be Bill Clinton, says New York-based psychologist Michael Shulman: his reputation as a “lovable rogue” helped him keep the presidency despite his transgressions.

We probably all lie much more than we realise. In one study, Feldman filmed students interacting with a stranger for 10 minutes. When he replayed the footage, the volunteers were surprised at how much they had lied – on average two or three times. When it comes to lying, the truth is we are already getting away with it.

**Alison George**

## CHOCOLATE

There are worse sins than being a chocoholic. Much of the UK’s chocolate industry was set up by Quakers trying to tempt people away from booze. Now we are hooked on chocolate instead. In the UK, each of us scoffs an estimated 7.5 kilograms every year.

Is that a bad thing? Dark chocolate has been branded a superfood in recent years, after studies showed eating 100 grams boosts heart-protecting antioxidants in the blood for several hours. Milk chocolate, and even dark chocolate consumed with milk, doesn’t have the same effect –

compounds in the milk seem to bind to the antioxidants and stop the body from absorbing them.

Weight for weight, milk chocolate has the downside of more fat and calories, too. The easiest way to deal with overindulgence is to exercise, but the effort might make you spit out your Mars bar. To burn off a standard-sized one, you would need to run up flights of stairs for roughly 20 minutes.

A shortcut to having your chocolate cake and eating it is to adopt a fasting diet, which typically entails eating just 500 to 600 calories a day for two days

of the week, and whatever you want the rest of the time. One study of over 100 obese women found that dieting this way over six months led to the same weight loss as sticking to a more conventional calorie-controlled diet 24/7. And fasting led to greater improvements in blood-sugar control.

Still, severely cutting your calorie intake, even for a day or two, isn’t for everyone. Most chocolate bars are about 30 per cent fat, so reducing that content without compromising the flavour might help. One way is to replace some of the fat by an

emulsion of cocoa butter and water.

This method, pioneered by French gastronome Herve This, is practised by chocolatiers such as London-based Aneesh Popat. “Water, having no taste of its own, leaves the consumer to enjoy unadulterated pure chocolate,” he says. Popat’s delicacies are served up in Michelin-starred restaurants, but you can make your own low-fat version at home using agar (*New Scientist*, 21 December 2013, p 53). Just make sure you stash them in the fridge well before the craving hits.

Catherine de Lange

## INACTIVITY

Sitting is the new smoking. Sedentary lifestyles are being blamed for cardiovascular disease, diabetes and even some types of cancer, and the World Health Organization recommends that adults do two and half hours of moderate exercise or 75 minutes of intense exercise each week. Couch potatoes may scoff at this idea, and they are in good company: around half of people in the US, as well as 37 per cent of men and 45 per cent of women in England, fail to do even this modest amount. Often we blame lack of time. Is there an easier way?

"Any exercise is better than nothing," says Chris Easton at the University of the West of Scotland in Paisley, UK. "There's no question that any exercise you do leads to reduced risk factors for mortality."

One shortcut is high-intensity interval training, or HIIT. Its devotees claim you can get fit by exercising in short, intense bursts a few times a week, a "go hard, then go home" approach backed by numerous studies.

Richard Metcalfe, then at Heriot-Watt University in Edinburgh, UK, and his colleagues did some particularly encouraging research. They found that 10 minutes of leisurely cycling, interspersed with two 20-second sprints, three times a week, boosts cardiovascular fitness as much as more conventional routines. Participants didn't judge the workout as particularly arduous either, despite the strenuous sprints.

If even that sounds too much like hard work, some researchers have begun to question whether current exercise guidelines are overzealous. "I think you'll start to see a shift where the message will change to 'do something,'" Easton says. A recent study from the University of Utah found that sedentary people who took a stroll every hour for



Live slow, die young

just 2 minutes were 33 per cent less likely to die in the three-year follow-up period than those who just stood up for two minutes instead.

It also seems that the first 15 to 20 minutes of exercise bring the biggest benefits. One study of over 400,000 people in Taiwan found that those who did just 15 minutes a day in total – half the recommended amount – lived on average three years longer than those who were inactive (see diagram, below). The first 20 minutes of exercise are so effective that each session could add half an hour to your life. **Catherine de Lange**

## RED MEAT

A succulent steak with creamy peppercorn sauce or a chunky burger laden with cheese. Could there be a better route to heaven (via a heart attack)?

Meat often gets a bad rap when it comes to health. When consumed in abundance, red meat probably does raise the risk of colorectal cancer and cardiovascular disease.

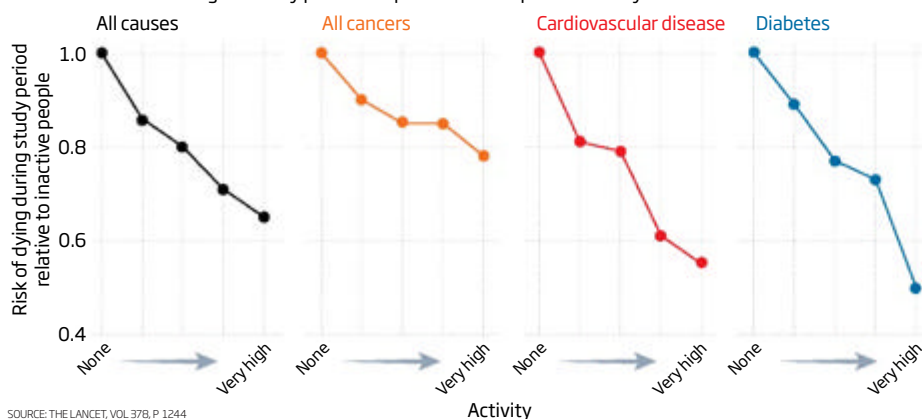
So what do you do if steak and blue cheese just happen to be your favourite flavour combination? Well, you might be on to a winner – it's just possible that adding dairy to your meat consumption might limit the damage.

First, it might help mop up some of the fat. France has one of the highest levels of cheese consumption in the world, yet one of the lowest levels of coronary heart disease. Some put this down to the fact that the French also consume a lot of vegetables, but several studies suggest that consuming cheese or milk causes a drop in the levels of "bad" LDL cholesterol in people's blood. "When you look at people who eat a lot of cheese compared to those who don't eat any, there's no difference in cardiovascular risk or diabetes – and if anything it tends to be beneficial," says Arne Astrup at the University of Copenhagen in Denmark.

One possible explanation is that the calcium present in abundance in cheese is binding to fatty acids and cholesterol in the gut, causing some of them to be excreted. However, giving people

## A little goes a long way

An eight-year study of 400,000 people in Taiwan showed that even low levels of activity reduced the likelihood of death during the study period compared with complete inactivity



SOURCE: THE LANCET, VOL 378, P 1244





Never eat  
processed meat

calcium supplements doesn't seem to have the same beneficial effect. It's also possible that certain bacteria or fermentation products in the cheese influence the balance of nutrients that are absorbed by the body.

### SUPER SPUDS

Calcium consumption could also be a way to reduce the damage caused by another constituent of red meat: heme. This iron-rich substance plays a key role in transporting oxygen around the body, but free heme can react with DNA in the cells lining the gut and boost the risk of developing colorectal cancer.

Calcium seems to mop up heme and render it harmless; rats fed a heme-rich diet seem to be protected against its carcinogenic effects if calcium is added to their food. Sadly for steak-lovers, high levels of calcium react with protein, rendering meat hard and dry. Adding milk, cheese or yogurt to the meal might have the same effect, but it's unclear how much you would need to eat to negate heme completely. And high cheese consumption is bad for your waistline and so can bring health problems of its own.

What about vegetables? The EPIC trial, one of the largest investigations into the health effects of red meat, found that the early death risk was lower in meat eaters who reported consuming lots of fibre (abundant in many plant-based foods) than in

people who ate very little meat. Similarly, people benefit from eating cold potatoes with their meat. It appears that what is called butyrylated resistant starch, produced when potatoes are cooked and then left to cool, protects against DNA damage to gut cells and so may blunt red meat's association with colorectal cancer.

Then there's processed meat, widely considered more harmful than fresh on account of the nitrite preservatives used in its production. These can react with fats in the diet and produce other cancer-promoting substances. Here, too, fruit and vegetables may provide a solution as some of them

**"Eating dairy with your meat might just help to limit the damage"**

contain chemicals called flavonoids. Concentrated flavonoids are currently being investigated as an alternative to nitrites for preserving meats. "They stop microbes from growing and the meat has a shelf life which is acceptable to meat producers," says Gunter Kuhnle at the University of Reading, UK. "The idea is to help the food industry to produce meat where the links with colon cancer are at least reduced, or maybe not there at all." Linda Geddes

## LATE NIGHTS

From burning the midnight oil at work to partying until the early hours, most of us have cut corners when it comes to sleep. That can have a serious impact on our ability to function. According to Charles Czeisler at Harvard Medical School, being awake for 24 hours will leave you with the same level of cognitive impairment as having a blood alcohol volume of 0.1 per cent, which would push you over the drink-drive limit in several countries.

The areas of the brain involved in attention, judgement and sensory processing are particularly hard hit. Accident statistics bear this out: traffic accidents peak in the early hours when the circadian drive for alertness is at a low, and our drive for sleep is the strongest. The impact on abilities depends partly on age; lab tests show that young people's reaction times suffer more than older people's after being kept up all night. Lack of sleep also affects the parts of the brain in charge of emotions and decision-making, and makes people more impulsive.

Can you counter such effects? Stimulants like caffeine can mitigate the effects of sleep loss, but a better strategy might be to catnap your way to a more coherent state of mind. "You can certainly offset the impact of sleep loss by strategic napping," says Judith Owens at Boston Children's Hospital. A short nap of just 10 to 30 minutes can improve alertness for 2 to 3 hours afterwards. A nap exceeding half an hour will have longer-lasting benefits, but is likely to leave you feeling even more groggy than before you nodded off, a phenomenon known as sleep inertia. An expert tip for avoiding that is to drink a cup of coffee just beforehand. The caffeine will kick in after about 20 minutes – in time to wipe away that hazy feeling when you wake.

Trying to get away with lack of sleep over the long term is much more risky. For one thing, its effects are much more insidious. Sleeping for 6 hours a night instead of 8 for two weeks, for instance, produces the same cognitive deficits as going 24 hours without sleep. But you may not pick up on it – people stop feeling as tired after the third or fourth day of sleep deprivation, even though their abilities are still deteriorating.

The effects of long-term lack of sleep are harder to get away with too, with elevated risk of diabetes, cardiovascular disease and some cancers. And if you have been repeatedly burning the candle at both ends, it can take weeks to recover, Czeisler says.

What about the idea that you can undo the damage with a very long recovery sleep? Probably not. "It's not like you can bank sleep," Owens says. "We don't know whether short sleep during the week and sleeping in at the weekends impacts people's long-term cardiovascular morbidity. But the evidence we have so far suggests that it's not a good way of dealing with it." **Catherine de Lange**

## SCREEN TIME

Text neck, *Candy Crush* thumb, iPad hand – the list of screen-related ailments is growing. Add in claims the internet is rewiring our brains, and the 4 or 5 hours a day we spend poking at phones and tablets starts to look like a health risk.

Most of these problems have a quick fix, though. Let's take the physical injuries. Text neck – looking down at a screen in your hands – puts strain on your upper back. Surgeon Kenneth Hansraj at New York Spine & Rehab Medicine claims that dropping the chin by 60 degrees is equivalent to making the spine support an extra 12 kilograms. And long periods spent jabbing and swiping or holding a tablet in an awkward grip can lead to stress injuries in the hands and thumbs. The compulsive playing of video games can also reduce pain sensitivity, meaning you could be damaging yourself without realising it. So keep your chin up and take regular breaks, regardless of how you feel at the time.

There are more subtle problems, too. Screens

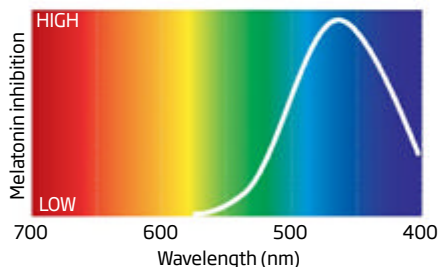
are strong emitters of blue light, which inhibits the production of the sleep-promoting hormone melatonin (see diagram, below left). So using them in the evening can shift our circadian rhythms out of whack, and even cause insomnia. In one study, Anne-Marie Chang and her colleagues at Harvard Medical School got volunteers to read from either an iPad or a book for four hours before bedtime over two weeks. When reading from the iPad, melatonin secretion was delayed by an hour and a half. The volunteers also felt more tired the next day compared with when they read books, and spent less time in REM sleep, which is thought to help us consolidate memories. The easiest fix is to switch off a few hours before bed, or use e-readers that don't emit blue light. If you must doze off to your favourite box set, reduce the brightness of your screen via your device's settings or a screen dimming app.

Screen time also tends to mean being inactive. In a study of 4512 people in the UK, Emmanuel Stamatakis at the University of Sydney, Australia, and colleagues found that those who spent more than 2 hours a day in front of a screen were more than twice as likely to have cardiovascular disease regardless of other common risk factors such as smoking, being overweight and social class. So try not to make screen time an additional reason to laze about.

And the impact on our brains? Kathryn Mills at University College London has reviewed studies to date and found no evidence that internet use has an impact on cognitive development. "Our brain is always changing; that's how it works," says Mills. "If all of a sudden you had to adapt to not having the internet, you would be fine." Douglas Heaven

## Night light

Our phones and tablets emit plenty of blue light – the colour that most reduces production of melatonin, the hormone that makes us sleepy at night



SOURCE: JOURNAL OF NEUROSCIENCE, VOL 21, P6405



POL/FOTO/PMCA

## BOOZE

If you like to end the night with tequila slammers, a pounding head could be the least of your worries. In the long run, drinking to excess risks harming your liver and other organs, various cancers and raised blood pressure.

Moderate drinking was thought to offer some protection against cardiovascular disease. One study found that a small drink every other day can reduce the risk of heart attack by a third, possibly because alcohol helps thin the blood. That study was in men, and more recent research suggests that the only people who might stand to benefit from light drinking are women over 65.

## WEIGHING UP THE RISKS

Calculating whether your guilty pleasure pays is hard: statements about health risks and benefits can be tricky to wrap your head around.

With activities like motorcycling or skydiving, one way is to think in micromorts – a micromort being a one-in-a-million chance of dying then and there. This unit is useful for pursuits that could kill you on the spot, says statistician David Spiegelhalter of the University of Cambridge. "When you do these activities, you are going to be healthy unless you are dead."

For lifestyle choices that chip away at good health – eating to excess, or smoking – think instead in microlives. A microlife is a millionth of a life, and equates to about half an hour. Spiegelhalter reckons that, for regular smokers at least, every two cigarettes costs one microlife. "This enables you to make comparisons across broad ranges of activities using common units, and without having to use very technical units like person years lost per something, or hazard ratios," he says.

Let's weigh up skydiving against

riding a motorbike. Seven to 10 people die for every million parachute jumps, so that's 7 to 10 micromorts. On a motorbike, you'd do about 10 kilometres before reaching 1 micromort. So one skydive is like 80 kilometres on a motorbike.

Microlives are useful because of the psychological barrier we put up when considering the long-term health consequences of our actions. "It's all to do with the end of your life and people, especially young people, tend not to care so much about living an extra year being old and dribbly.

So the idea of the microlives is that this is happening to you now. You're ageing faster because of your behaviour," says Spiegelhalter.

Good habits can also improve life expectancy. Spiegelhalter has devised a microlife calculator (see right) which can help you see whether your good habits outweigh the bad. "The image is of course coming out of the gym and going to the pub," says Spiegelhalter, "which when I used to go to the gym is what I always used to do. But it's not to be encouraged." Catherine de Lange





Make it a half

If you find yourself dragged into a drinking game and want to keep your head while all about are losing theirs, is there anything you can do to ward off intoxication? There's nothing proven to help yet, but there's promise in a traditional Chinese remedy: an extract from the oriental raisin tree *Hovenia dulcis*. Known as dihydromyricetin (DHM), it binds to receptors for the neurotransmitter GABA, which in turn blocks ethanol's intoxicating effect, says Jing Liang of the University of California, Los Angeles.

### SPRY AND DRY

Popping one DHM pill while drinking won't reduce your blood alcohol level, but should in theory reduce intoxication. It works in rats, says Liang, and people who take DHM while still under the influence of alcohol report improvements in concentration and clarity of thought.

A more natural way to soothe the liver is to give it a little holiday. "Dry January" is often touted as a way to get a health boost after seasonal indulgences, but there's little research to back this up. So in 2013, 14 *New Scientist* staff tried it out. Ten gave up drink for five weeks and saw an average 15 per cent reduction in liver fat, whereas the other four saw no change; too much fat in the liver can lead to liver disease. The abstainers' blood glucose and cholesterol levels also improved markedly. It seems a month on the wagon can offer fast, dramatic health effects.

If you have more money than brain cells left following a big night out, you could consider what is regularly touted as "the latest celebrity trend": pricey intravenous infusions designed to replace the fluids you lost the night before. Just like tequila, you might want to take that one with a pinch of salt. **Sean O'Neill**

Even so, there are things you can do to maximise the pleasure and nix the pain. If you wake up with the start of a hangover, trust your instinct and keep the curtains tightly closed. Analía Karadayan and her colleagues at the University of Buenos Aires in Argentina gave mice alcohol and then monitored their hangovers. Under normal day/night conditions, the animals took about 20 hours to get back to their normal levels of activity and coordination. But mice left to recover in total darkness were fighting fit in just 8 hours. "Hangovers can break the operation of our internal clock, so darkness could encourage recovery," says Karadayan.

## ACCOUNTING FOR TASTE

Activity	Microlives
2 hours watching TV (sedentary)	-1
Smoking 2 cigarettes	-1
First unit of alcohol of the day	+1
Each subsequent unit (up to 6)	-1/2
First 20 minutes of physical activity	+1
Each subsequent 40 minutes	(men) +1 (women) +1/2



PETER ROOFS/PLANPICTURE

Better than tomatoes

## SUNBATHING

Only mad dogs and Englishmen go out in the midday sun, the song goes. Catching too many rays causes wrinkles and freckles at best, and deadly cancer at worst. And yet nothing feels quite as good on the skin as the warm kiss of the sun's rays. This feel-good factor - which may even elicit a response akin to addiction - might have evolved from our need for sunlight to make vitamin D.

What's a prudent person to do?

The one thing nobody should try to get away with is sunburn, which not only hurts but has been shown to double the risk of melanoma, the rarest but most dangerous form of skin cancer. "All sun exposure causes cell mutations that may eventually lead to cancer, but sunburns exacerbate this effect," says Eleni Linos at the University of California, San Francisco. "It's a very intense dose."

How much sunning you can do in relative safety varies from person to person. "It really depends on your skin type," says New York-based dermatologist Michele Green. The darker the skin, the higher the concentration of melanin, a pigment that shields

"Nothing feels so good as the sun's warm kiss - but is it deadly?"

skin cells from the damaging effects of UV rays. "It is kind of like a natural sunscreen," Linos says. People with Mediterranean, olive-toned skin, for instance, are half as likely to develop melanoma than those with very pale skin.

To help you navigate the issues, there are wearable devices that tell you how long you can reasonably spend in the sun without protection to get a vitamin D boost. Then there's sunscreen: an SPF of 15 means the user can stay in the sun 15 times as long without burning.

Taking anti-inflammatory painkillers can reduce the risk of common skin cancers by around 15 per cent, but doing so regularly carries its own risks. A more tasty solar defence could be to eat tomatoes. A small study recently looked at the effect that eating 55 grams of tomato paste daily for 12 weeks had on how 20 women's skin reacted to UV exposure. "Those that were on tomatoes had increased sun protection in their skin," says Mark Birch-Machin at Newcastle University, UK, one of the study's authors. The key is the tomato's antioxidant properties, he says, adding that green tea and blueberries might have similar benefits. The foods are no substitute for sunscreen, however. "They just provide a little bit of extra protection," he says. Sonia van Gilder Cooke

## DRUGS

If mind-altering substances are your thing, you're spoiled for choice. Besides marijuana, cocaine, ecstasy, LSD and mushrooms, a growing "long tail" of chemicals toast your oats in every conceivable way.

There's a reason why drugs have a reputation for being bad for you: they are. Yet at least 160 million people (and possibly twice as many) indulge at least once every year. So if you fancy a trip to an altered state, how best to get away with it?

The answer depends on what you mean by "getting away with it". You can't guarantee a safe experience. But an informed choice can give you the best chance of avoiding potential harm.

### DOUBLE TROUBLE

Drug harms fall into two broad categories: those that affect you, and those that affect others. The personal ones include death, health problems (including mental health), accidents, addiction, relationship breakdown and legal trouble. Harms to other people include violence, financial problems, crime and environmental damage – both at home and where the drugs are produced.

One rule of thumb is that risks become more serious with repeated use. Take addiction, for example. According to the US National Institute on Drug Abuse, it can take only "a few" uses of a drug to become addicted to it, although the potential for addiction varies between drugs and people. Putting firm numbers on this is difficult, but a study

published in 2005 found that among a large cohort of people who tried cocaine for the first time, more than one in 20 were dependent on it two years later.

Perhaps the best guide to the harms comes from the UK's Independent Scientific Committee on Drugs (ISCD), which analysed 20 drugs on 16 criteria. It found the most harmful illicit drug to be heroin, with an overall rating of 55 out of 100, with crack cocaine on 54 (see diagram, below). LSD and magic mushrooms are among the least harmful, and also carry the lowest risk of dependence.

Mixing drugs amplifies the risks. Taking cocaine with amphetamines or ecstasy, for example, raises the risk of acute toxicity over and above the sum of their parts. This also extends to nicotine.

And of course, most of these drugs are illegal in many places. As well as the potential for falling foul of the law, users often can't be sure what they are taking. Some nightclubs offer a testing service to analyse the contents of party pills, but on the whole the only "guarantee" is the word of the drug dealer.

When it comes to the benefit side of the equation, the picture is even less clear. Nobody has yet done an analysis taking into account the pleasure, fun and adventure that people seek when they take drugs.

All told, you might conclude that trying to get away with taking drugs isn't worth the risk. If so, this would also rule out a widely consumed and enjoyed substance that the ISCD rated as the most harmful drug of all: alcohol. **Graham Lawton**

## SOCIAL SMOKING

Smoking is one of the worst things you can do for your health. Regular smokers shave half an hour off their life with every two cigarettes (see "Weighing up the risks", page 34). But what about social smokers, those who fancy the odd cigarette normally accompanied by a drink or two?

According to the British Heart Foundation,

**"Occasional smoking is on the rise – can it really be that bad?"**

there are 1.1 million occasional smokers in the UK. And a study of smoking in 31 US states found that the proportion of smokers who didn't light up every day is on the rise – jumping from 16 to 21 per cent between 1996 and 2001.

Occasional smokers tend to be categorised either as not smoking every day, or smoking an average of less than one cigarette a day. Can the health effects of such a habit really be that bad?

Some of the risks certainly pale in comparison to those of smoking 20 a day. Take cancer – the risks increase the more you smoke, says John Britton at the University of Nottingham, UK. "Every cigarette you smoke increases your chance of getting lung cancer, it's as simple as that." Each one causes irreversible structural damage, too. Fine particulate matter in the smoke causes damage to the lining of the lungs, the cumulative effects of which lead to serious breathing disorders.

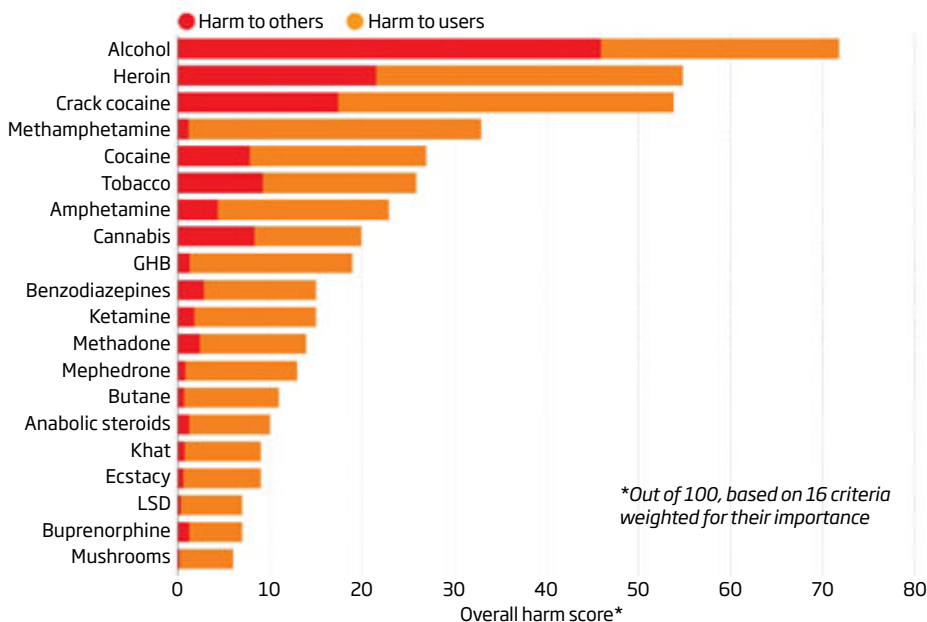
And any social smoker who thinks the harms can be undone by more virtuous habits, such as exercise, is kidding themselves, Britton says. "Doing more exercise or even stopping smoking will not reverse this damage," he says. "It's a complete fallacy that your lungs can somehow regenerate."

The news is even worse when it comes to cardiovascular disease and heart attacks – the biggest immediate risks for social smokers, says Robert West at University College London. "Unlike the risk of cancer or respiratory problems, which increase linearly with every cigarette smoked, the risk of heart disease is very non-linear, with the highest jump coming with the first cigarette and increasing gradually thereafter," he says (see graph, right).

Intriguingly, smokers have been found to have better survival rates when admitted to hospital after a heart attack, or traumatic injury, compared with those who never smoked. This could be because some of the bad effects of smoking, such as over-activation of the body's inflammatory response, or causing platelets in the blood to form

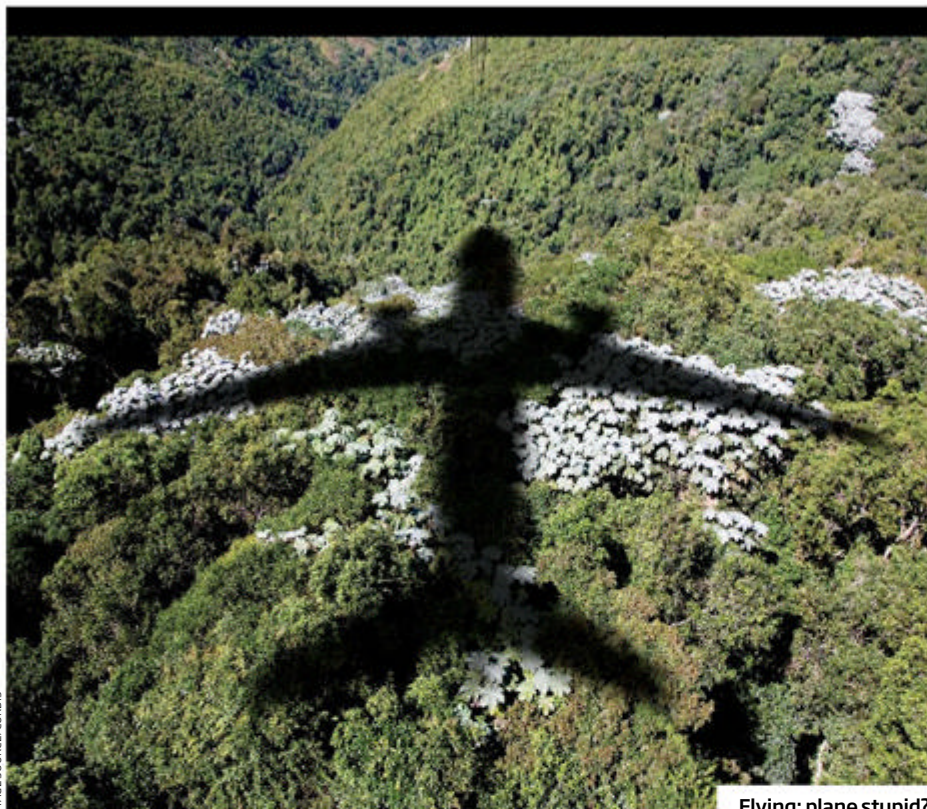
## Is it worth the trip?

The most dangerous drug isn't illegal



SOURCE: THE LANCET, DOI.ORG/10.1016/S0140-6736(05)25555-5





Flying: plane stupid?

clots, could be protective in a life-threatening situation. Clearly, though, this “smoker’s paradox” is no reason to keep up the habit, and the mechanisms at work are still under investigation.

There is more practical good news though. Quit social smoking now, and you might be able to get away with a lot. Within a year your excess risk

(relative to someone who has never smoked) of smoking-related heart disease will be halved. And by giving up before the age of 30, people can reduce the excess risk of dying of smoking-related causes by more than 97 per cent.

Recent research suggests quitting could also claw back some years lost to your lifespan. Among those who die of cardiovascular disease, smokers do so on average 5.5 years earlier than non-smokers. For ex-smokers, the gap goes down to 2.5 years – even if they quit as late as their 60s.

### E’S ARE GOOD

Of course, quitting is often easier said than done. Even occasional smoking is addictive. Social smokers might not struggle to get through the day without a cigarette, but they tend to have a strong psychological addiction, triggered by certain situations. Even those who smoke fewer than one cigarette a day struggle to give up when they want to, with 65 per cent relapsing within 6 months of their quit attempt. Electronic cigarettes might be a good trick to deal with their situational craving, West says. “E-cigarettes are certainly less toxic than tobacco ones. We don’t yet fully understand the long-term consequences, but in the short term, e-cigarettes are a good option – or at least a less bad option than cigarettes.” Dara Mohammadi

## FLYING

You’ve insulated your house and turned down the thermostat. You’re eating less meat. You cycle to work. But a few times a year you fly.

In the UK, the average carbon footprint is around 10 tonnes a year, excluding flying – but a single round trip to New Zealand produces 12 tonnes of CO<sub>2</sub>. Is flying ever going to be anything other than the greatest of green sins?

The short answer is no. There isn’t much scope for making planes more efficient, and nor have efforts to develop alternatives to fossil fuel-derived kerosene got very far. The ethanol-powered Embraer EMB 202 Ipanema does run entirely on biofuel, but it’s a single-seater used for crop dusting. Powering airliners with ethanol is problematic, not least because it freezes at normal cruising altitudes.

Flying cattle-class can help, because the more people crammed on a plane, the lower the per-person emission. But beyond this things get complicated. Planes burn fuel fastest during take-off, so you might think short-haul flights are worse. But the longer the flight, the more fuel is carried, and the more fuel is burnt to carry this fuel.

Claims that summer flights are better – because fewer heat-trapping contrails form then – are mired in uncertainty. Another suggestion is that flying during the day is better because contrails also reflect sunlight, compensating slightly for the heat they trap, but the difference may be negligible. As for taking less luggage, a jet can weigh 400,000 kilograms on take-off, only a tiny fraction of which is luggage.

So what about offsetting your emissions? The idea is that you pay a little extra to support projects such as installing solar panels or planting trees. But the quality of offset projects varies, says Anja Kollmuss, an independent environmental consultant based in Zurich, Switzerland. Most companies selling offsets claim their projects are “verified”, but this is no guarantee of quality, Kollmuss says, nor that the projects in question wouldn’t have happened even without your contribution.

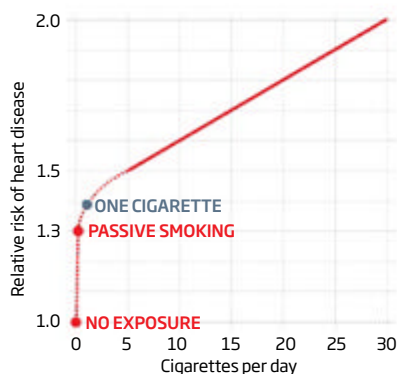
When it comes to planting trees, say, what matters is that the trees survive for decades to come. If they die or are cut down, the CO<sub>2</sub> they locked away just ends up back in the atmosphere. “There are good offset projects out there,” says Kollmuss. “But it is very difficult for consumers to identify them.” Another option, she suggests, is that every time you fly you donate money to an organisation campaigning for action to prevent climate change.

Supporters of offsetting argue that it is at least better than doing nothing. But not even this is clear – opponents claim people who buy offsets may feel less guilty and fly even more as result. The bottom line is that if you can avoid flying, do.

**Michael Le Page ■**

## Drag and drop

Smoking just one cigarette a day can increase your chances of heart disease by nearly 30%



SOURCE: BMJ, VOL328, P980

The internet can bring out the worst in us. But taming the beast may just be a matter of finding the right words, says Tienlon Ho

# It's good to talk

**A**S ARTURO BEJAR clicked through the millions of photos it was hard to see what was wrong with them. Happy couples, cute puppies, every now and then a person caught mid-chew. Yet each had upset someone enough to ask Facebook to delete it.

Bejar could hazard guesses for the reasons behind some of the requests – maybe this couple had broken up, maybe that guy was embarrassed by his double chin. But the person who reported the photo was usually in it and the person who posted it a friend. People were asking Facebook to intervene in personal grievances. Why not work it out themselves? One common complaint was people posting pictures of other people's children. For Bejar, Facebook's director of engineering, it was as if your photographer brother-in-law decided to exhibit photos of your kids. Would you ask the gallery to take down the photos instead of talking to your brother-in-law?

We tend to think that technology has magical properties that change who we are, says psychologist Dacher Keltner at the University of California, Berkeley. But that's not the case. "Facebook has all the problems that real life has. It's still just human society."

What was needed was a way for people to interact online more like they do offline. Bejar put a team together to bring compassion to our online interactions. With more users than the population of China, if Facebook could get people to talk things out, it would establish a new standard for how we behave on the internet. Compassion could go viral.

Most social media platforms, from Facebook and Twitter to YouTube and Vine,

have some kind of reporting or "flagging" system to manage content. The monitoring of flagged material is carried out by moderators trained to enforce the site's community standards. In Facebook's case, that means depictions of violence or nudity get deleted, as do posts containing hate speech.

Policing, though, has obvious limitations. What counts as acceptable can depend on context, which varies between cultures and social groups. With more than 80 per cent of its active users outside the US and Canada, Facebook is unlikely to get it right all of the time. And since policing puts moderators in the role of a teacher meting out justice, it is also a lot of work.

Bejar wanted to do better. By revamping Facebook's system for flagging posts, he hoped not only to cut down the millions of photos to be sifted through each week but also to improve people's experience of using the site. But that's not as simple as it sounds. One of the biggest challenges to online communication is typing. "People don't realise the written word is quite different from the spoken word," says Keltner, who is on Bejar's team. With text, we lose out on cues such as eye contact, touch and tone of voice that convey a lot of information.

In 2005, for example, Justin Kruger at New York University and colleagues found that we are significantly worse at conveying what we mean to say in an email compared with when we talk – yet we still believe we are being perfectly clear. People greatly overestimate their ability to communicate clearly online.

What's more, the internet brings out the Mr Hyde in all of us. Psychologists have long

noted how masked trick-or-treaters are more likely to behave selfishly, for example. John Suler at Rider University in Lawrenceville, New Jersey, has suggested that computer screens have a similar effect, with people doing and saying things they wouldn't face-to-face. "There's been an exponential rise in a form of communication that we're not yet equipped to handle," says Keltner.

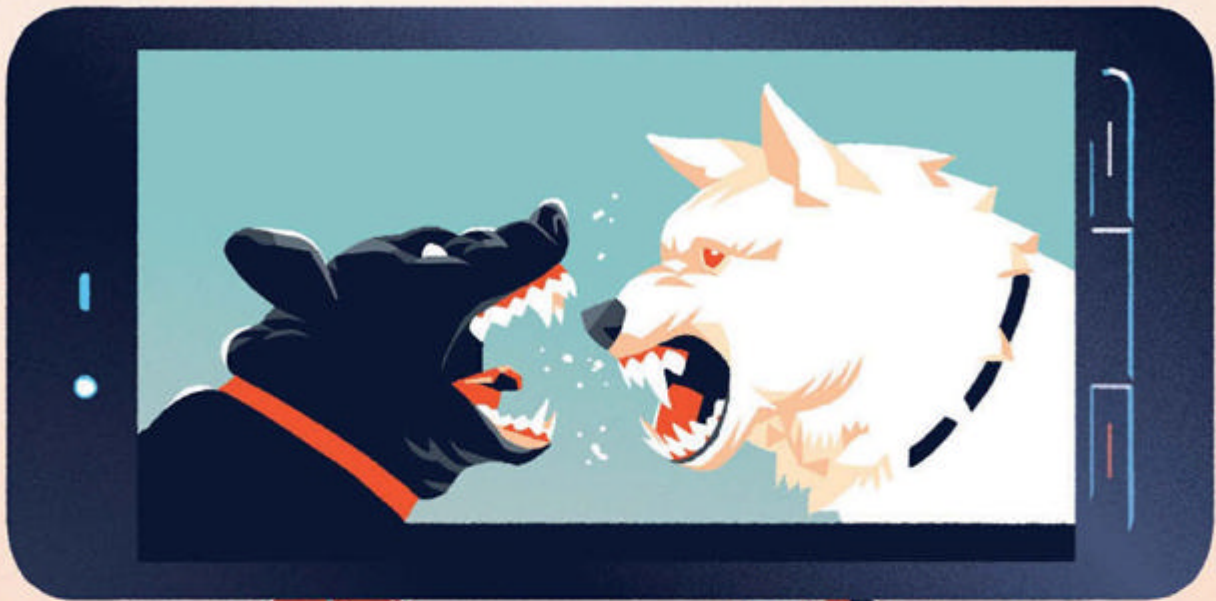
## Friendly feedback

In 2012, Bejar assembled a team of engineers and psychologists at Facebook's headquarters in Menlo Park, California. At the time, Facebook offered people three choices for dealing with a friend's post they found upsetting: report content that violated a Facebook policy, hide it from their personal view or "unfriend" the person.

It was a limited palette. "There was no opportunity for the feedback – the disdain or disapproval, the recognition or approval – that a person would have felt in a face-to-face conversation," says social neuroscientist Emiliana Simon-Thomas at the University of California, Berkeley. The commonly chosen option to unfriend the other person killed the conversation. And reporting relied on Facebook to act, which it could only do if the content violated one of its policies.

"We needed to make it easy for users to explain what they were feeling instead of relying on an authority to take care of things," says Simon-Thomas. "This may all seem obvious, but it shows you how much of a chasm there has been between the fields of





# "THERE'S BEEN AN EXPONENTIAL RISE IN A FORM OF COMMUNICATION WE'RE NOT YET EQUIPPED TO HANDLE"

## CROWD CONTROL

Subtle tweaks to Facebook's algorithms can have seismic effects. Last year, for example, there was outrage over the ethics of treating Facebook users as guinea pigs in a study looking at the effects of its newsfeed algorithms. But Facebook has always tweaked what we see. "This was part of ongoing research companies do to test different products," COO Sheryl Sandberg said at the time. "We never meant to upset you."

Facebook is also out to change how we behave (see main story). For example, during the 2010 presidential election in the US and the recent general election in the UK, an "I voted" button let users tell others when they had cast their ballot. Robert Bond at the University of California, San Diego and colleagues estimated that Facebook had increased US voter turnout in 2010 by around 340,000.

And in February, Facebook announced its "Speak Panzagar" campaign to promote civility in Burma. It launched cartoons with positive slogans that can be shared between the country's 600,000 Facebook users. Panzagar, which means "peaceful speech", is a grassroots effort in Burma to counter hate speech aimed at the country's Muslim minority. Slogans include "Think before you share" and "Don't believe it". According to Facebook, the cartoons quickly became the most widely shared "sticker" – illustrations or animations sent between Facebook friends – in Burma, and proved "an extremely powerful way to promote civility".

technology and social science."

The team added an option so people could contact others who had posted a photo they wanted removed. At first the team provided a blank box in which to compose a message, but only 20 per cent of people used it. So they filled the box with a default response. Simply adding the words "Hey, I don't like this photo. Please remove it" got more people using the system (see "A way with words", right).

Then they started tweaking. Letting people select why they didn't like a photo from a list that included options like "It makes me sad", "It's embarrassing" or "It's a bad photo of me" bumped up engagement even more. By giving people prewritten text that added emotional context, the rate of one-to-one interaction tripled. Once they started experimenting, the team found that minor tweaks made big differences. With more than 1.4 billion active monthly users, Facebook was affecting a whole lot of people.

Softening our written words was key. We tend to read the worst into online messages because they offer so few emotional cues. Research by Kristin Byron at Syracuse University in New York suggests this negative effect is amplified when we read messages from someone of higher status, such as our boss. He found a difference between the sexes too: men tend to use fewer positive emotional cues in their emails than women, for example.

"This is one of the reasons why sarcasm is so hard to get across," says Simon-Thomas. "No one ever gets the smirk." To help people get the joke, the team designed emojis – small images of faces – to allow an even broader range of expression. We may be learning to process such images emotionally. A recent Australian study found that ":-)" activates the same areas of the brain that process facial expressions.

Smiling may be universal, but many things aren't. When Facebook's dispute process began reflecting cultural differences, it doubled the number of people choosing to resolve issues themselves. In India, where making fun of a favourite celebrity is deeply offensive, people can choose "This photo insults someone important to me". In Turkey, people can opt for "This promotes militant activities, violence, armed attacks or weapons".

For teenagers, the system needed to be adapted further. After leading teen focus groups, Marc Brackett, a Yale psychologist on the team who specialises in emotional intelligence, advised changing "Report this post", which to many implied getting a friend into legal trouble, to "This post is a problem".

"Kids took from the language that this was a

generic experience that didn't apply to them," Brackett says. "We avoided words like 'stalking' and 'harassed', and instead used 'threatened' or 'bothered', to make the experience much more conversational and applicable to them."

Depending on how embarrassed, sad or scared someone is, Facebook now offers different solutions. A user who is annoyed by someone's post – but doesn't necessarily want it removed – is given a separate option simply to tell that person how they feel. Teens may also be given a link to a bullying hotline and other counselling resources. There are guides for parents, teachers and even the bullies to help them understand what they can do better online and in real life. All of these changes doubled the number of teens seeking help or contacting the person who posted something hurtful, Brackett says.

Facebook is extending this direct and emotionally engaging approach across its business. In its privacy controls, for example, you now see "Who can see my stuff?" and "How can I stop someone from bothering me?" instead of legalese.

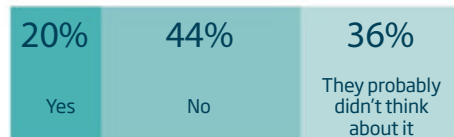
Facebook is also interested in looking at how anonymity can be used to communicate in a positive way. Rob Boyle, a product manager, says he can see potential in using anonymous signals to kick-start difficult conversations – like when you want to gently break it to a friend that posting about politics every 10 minutes is getting annoying. "We're looking to build more ways to convey subtle signals, without making it too easy to slide into the

### No offence intended

Surveys of people who have used Facebook's social resolution tools suggest that most people do not intend to cause offence

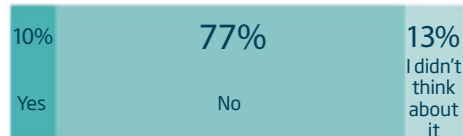
### Users requesting removal of content

Do you think the person who posted this meant to bother anyone?



### Users receiving requests for removal of content

Did you think this post would bother anyone?



SOURCE: ANDREW SOUVALL/FACEBOOK



## A WAY WITH WORDS

Tweaking the prompts people see when they contact another user about content they find upsetting caused more of them to use the system. Automatically generating a message to help a user express how they feel was three times as effective as leaving a blank box.

### Ask to have the photo removed from Facebook

- ☒ I don't want others to see me in this photo
- ☐ This photo is harassing someone
- ☐ This photo shouldn't be on Facebook
- ☐ This photo is spam

### I don't like this photo because:

- ☐ It makes me sad
- ☐ It's inappropriate
- ☐ It's a bad photo of me
- ☒ It's embarrassing
- ☐ Other

20%

Hey Jake, I don't like this photo.  
Please remove it

~50%

Hey Jake, this photo is a little  
embarrassing to me and I would prefer  
that people don't see it on Facebook.  
Would you please take it down?

~60%

negative," says Boyle. "It's a tricky balance, because the effects go both ways. That's why we've never done the dislike button."

This was a lesson learned by Disqus, which provides the discussion platform for the 1 billion monthly users of Wordpress, Tumblr and many other web sites. Disqus has been looking at how voting comments up or down affects conversations. CEO Daniel Ha is excited about Facebook's work because it gets people to stop and think. "As communication platforms, it should be our intention to get the best out of people rather than just their first reactions," he says.

## Thumbs up, thumbs down

Disqus added voting as part of a scoring system that moves the best comments to the top and alerts moderators to people who repeatedly post comments that get downvoted. In 2012, Disqus introduced a requirement that people log in to vote, and began displaying their name and profile picture next to comments they voted up.

Making votes more visible amplified the positive signals in the communities, says Ha. Reports of abuse fell by almost 80 per cent. But the change also began to encourage negative feedback. "We saw retaliation and vindictive trolling, people ganging up on each

other," says Ha. "People would obsess over who had voted them down."

Justin Cheng at Stanford University and colleagues looked at Disqus's data and found that positive feedback had no effect on what people posted, but downvotes made users more likely to post antisocial content. Downvotes changed behaviour in a way that poisoned an online community.

The solution, Disqus decided last year, was to hide all downvoting statistics, using them only as a background measure of quality. "We're seeing less noise and frustration," says Ha. "People are replying to each other, rather than just registering another downvote."

Del Harvey, Twitter's head of Trust & Safety, has also been following Facebook's work with interest. On Twitter, where fewer people know each other, building channels for direct communication isn't the best option. Instead, the solution may involve giving people more control over what they see, says Harvey. For example, Twitter may explore a form of community reporting in which people in your chosen network could rate tweets, and enough downvotes would hide the content from your view. New accounts that use language similar to previously flagged tweets are also filtered out. In addition, Twitter has tripled the number of staff policing its content.

By its own estimation, Facebook's efforts to

get us to behave better online have been a success – more than 8 million people use the social resolution tools each week to deal with conflicts over photos, status updates and shared links. For Facebook, the ideal outcome isn't necessarily the removal of the photo or post, which might be valuable to the poster. It is opening a dialogue.

The team tried to adapt the platform so that an emotionally intelligent response is the easiest thing to do. When asked to remove a photo, people do so more than half of the time, and around 75 per cent at least write back. Even if a handful of these replies are negative, the simple acknowledgement often helps people to get over their initial reaction.

Facebook may have helped millions of people express themselves, but some will feel uncomfortable with yet another example of subtle manipulation (see "Crowd control", left). However, the internet calls for special measures. Bejar says he started thinking about compassion technology because of his son. "I had set a personal deadline," he says. "I'd need to feel really good about the content on Facebook by the time he got an account."

"Now he is almost at that age, we're almost there," he says. "The broader internet is a different story." ■

Tienlon Ho is a writer in San Francisco, California





# INVASION OF THE MIND SNATCHERS

The idea that a feline parasite might hijack our brains sounds like a B-list horror movie. It isn't, says Colin Barras

**I**MAGINE there were a parasite living in your brain – an alien interloper with the power to alter your neurochemistry, manipulate your behaviour and change the way others see you. It might even rob you of your sanity. You are not the only person affected. The creature has taken up residence in the brains of billions of people, and many more are at risk.

This is not fiction. This mind-snatcher actually exists.

We already know that some parasites mess with their host's mind. The lancet liver fluke, for example, induces suicidal behaviour in any ant it infects, making it climb to the top of a blade of grass and hold on tightly with its jaws until it is eaten by a passing cow. Thus, the fluke gets back inside an animal in which it can reproduce, completing its life cycle. It is not the only parasite capable of such mind control, but generally their targets are insects and other small-brained invertebrates. Influence over a mammal with the brain size of a human was beyond their capabilities – or so we thought. That assumption is being challenged – at least for one parasite.

You may have heard of it. The microbe in question is *Toxoplasma gondii*, a single-celled protozoan that infects many birds and mammals but reproduces sexually in just one group: cats. Humans generally acquire it by eating undercooked meat and unwashed fruit

and vegetables, or from cleaning litter trays of cats that have recently been infected. Pregnant women and people with immune disorders such as HIV are advised to avoid these risks because *Toxoplasma* can occasionally be fatal to a fetus or to someone with a compromised immune system. But, for most of us, a mild flu-like illness is the worst we might expect. The symptoms of toxoplasmosis can be so innocuous, in fact, that most people don't even seek treatment. Soon, usually without us ever knowing we have the parasite, it enters a latent phase: it forms cysts, mostly in the brain, and hunkers down inside them, sitting dormant for decades, apparently doing nothing.

## Suicidal combination

Worldwide, at least 2 billion of us carry the parasite – some estimates put it at twice that. The only hint of its presence comes in the form of *Toxoplasma* antibodies in the blood. Or so we thought. But *Toxoplasma* does have form as a mind-snatcher in other animals. We know that it boosts its chances of ending up inside a feline gut by messing with the minds of mice and rats. In the mid-1990s, for instance, researchers including Joanne Webster, now at Imperial College London, UK, discovered that toxoplasmosis makes rodents more active and less fearful: a suicidal

combination that increases their likelihood of being caught by cats. The consensus was that the parasite could not pull off a similar trick in humans. But one man suspected otherwise.

Evolutionary biologist Jaroslav Flegr at the Charles University in Prague, Czech Republic, decided to investigate its effect on human behaviour. His findings surprised many people. In 1994, Flegr and colleagues reported that men infected with the protozoan were more likely than uninfected men to disregard rules, or to be excessively suspicious or jealous. A few years later, he used a computer-based test to show that infected men and women have significantly delayed reactions compared with uninfected individuals. The work attracted little attention at the time.

Then, in 2002, Flegr tested people responsible for traffic accidents in Prague for infection. The results confirmed his hunch: car drivers and pedestrians injured on the city's roads were more than twice as likely to be infected as a comparable group of people living in the same area. As in rats, the parasite appeared to be linked with reckless behaviour. The finding, which has since been replicated by other groups, has encouraged others to question whether *Toxoplasma* is more harmful to humans than we imagined.

Another factor contributing to the shift in attitudes is Webster's discovery of the way ➤

## "In humans, as in rats, the parasite appears to be linked with reckless behaviour"

in which the parasite exerts its mind control over rats. In 2000, she reported that toxoplasmosis doesn't simply make rats less fearful, it actually alters their sense of attraction, so that they find the smell of cat's urine alluring. Infected rats retain their aversion to the urine of other animals, leading Webster and her colleagues to dub the effect "fatal feline attraction". It no longer seemed likely that the personality changes seen in rodents – and people – with toxoplasmosis were merely a standard sickness response. Mammals have a naturally evolved suite of sickness behaviours, such as withdrawal and fatigue. But Webster's discovery of the powerful and precise way in which the parasite controls the mammalian brain suggested something else was going on.

What might that something be? A study in 2009 provides one possible answer. Glenn McConkey at the University of Leeds, UK, and his colleagues were analysing the *Toxoplasma* genome when they found something unexpected. The parasite carries two genes for tyrosine hydroxylase, an enzyme that helps produce a precursor of dopamine. There is no obvious reason why the parasite itself would need lots of dopamine, but in the mammalian brain dopamine acts as a neurotransmitter, playing a role in motivation, cognition, pleasure and fear. Could *Toxoplasma* be meddling with the brain chemistry of its hosts to change their behaviour?

It certainly might be. As early as the mid-1980s, researchers were reporting elevated

dopamine levels in rodents with toxoplasmosis. And a few years before McConkey's discovery, Webster and her colleagues found that haloperidol, a drug that inhibits dopamine production, prevents infected rats from displaying fatal feline attraction. But what about humans?

### Psychotic connection

It is not really known whether people infected with the parasite have elevated dopamine levels. Intriguingly, though, haloperidol is prescribed to treat schizophrenia, a mental condition thought to be caused in part by an overactive dopamine system. We already know of a correlation between toxoplasmosis and schizophrenia. And in 2008, researchers reported that people with *Toxoplasma* antibodies had an increased likelihood of developing schizophrenia, adding weight to the idea that the parasite might actually trigger the psychotic condition.

Other teams have not yet managed to replicate the finding, but evolutionary biologist Paul Ewald at the University of Louisville, Kentucky, believes it is only a matter of time before the link is accepted. "A strict genetic argument for schizophrenia just can't explain all of the evidence," he says. In other words, it can't just be down to our genes. He believes that about a third of all schizophrenia is triggered by toxoplasmosis.

For now, McConkey admits that we still need more evidence to show that *Toxoplasma* exerts



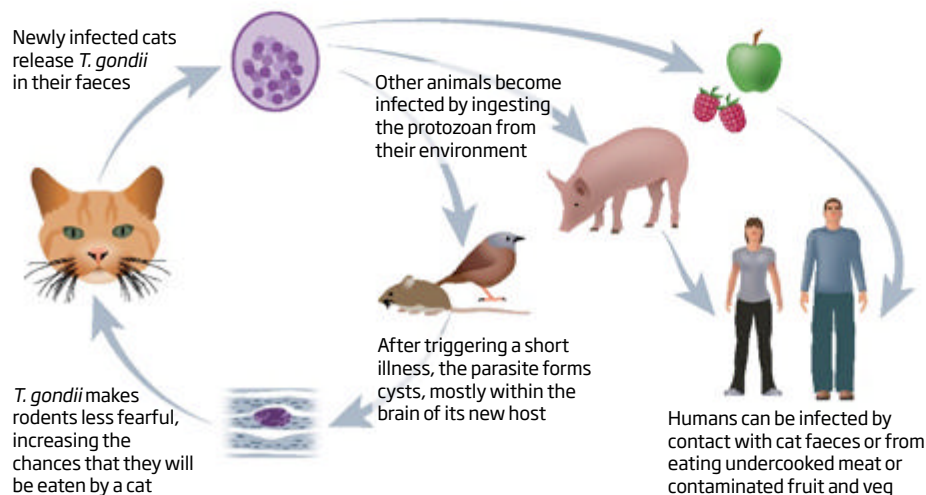
JIM DOBERMAN/GETTY

its control over the minds of mammals using dopamine. To be sure, we would need to block the activity of the two genes involved in dopamine production and see whether this affects its ability to manipulate behaviour. The first steps towards doing that have now been taken – with disappointing results. Researchers found that knocking out one of the protozoan's dopamine genes made no difference to the levels associated with toxoplasmosis in rodents. "I have some reservations about that study and the methods they used," says McConkey. However, he adds, it reminds us we should be careful about jumping to conclusions before we have all of the evidence.

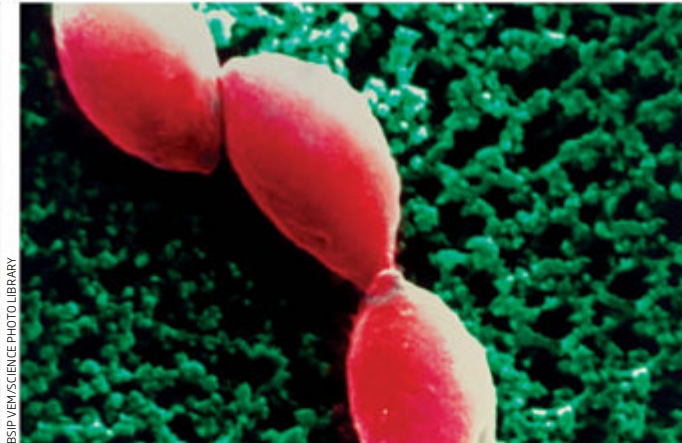
But there may be another explanation for *Toxoplasma*-induced mind control. Over the past five years, Ajai Vyas at Nanyang Technological University in Singapore has amassed evidence that *Toxoplasma* doesn't just go to a rat's brain: it also clusters in the testes, from where it can pass to females during copulation, ending up in around 60 per cent of their offspring. In other words, toxoplasmosis is a sexually transmitted disease. Vyas's findings suggest we have missed something important. *Toxoplasma* has two goals, he says. It is keen to get back into a cat, but more immediately, it's driven to spread to as many rodents as possible – so it can ultimately reach many more cats.

### The cat's got more than the cream!

The parasite *Toxoplasma gondii* infects most mammals but can only reproduce sexually in cats, so it manipulates the behaviour of other hosts to complete its life cycle







BSIP VEM/SCIENCE PHOTO LIBRARY

**Fatal attraction:** rats in thrall to the *Toxoplasma* parasite (above) find cat pee attractive

The parasite can achieve both goals by manipulating testosterone levels, says Vyas. Then, not only will infected rats devote more of their time and resources to breeding, they will also throw caution to the wind while they do so, boosting their chances of being caught by a cat. His findings support this idea. For instance, male rats with toxoplasmosis are judged by females to be particularly attractive. And the odour of cat urine induces sexual arousal in rats with toxoplasmosis. “Ajai’s work is quite intriguing,” says McConkey. “It does raise the possibility that there’s a lot more going on than we currently understand.”

Curiously, some parallel effects have now been reported in humans. Flegr has found evidence that men with toxoplasmosis have unusually high levels of testosterone, and tend to be viewed as particularly masculine and dominant by women. So does *Toxoplasma* pull most strongly on human brains or human groins? “This is speculation, but I don’t think there are multiple controlling strategies,” says Vyas. “I think it’s the same strategy with multiple nodes. My goal is to find the circuit that connects it all up.”

It is debatable whether *Toxoplasma* deliberately manipulates human behaviour, as some other parasites seem to (see “Micromanagers”, above right). Unlike rodents, we are not eaten by cats, so any mind-

bending effects of the protozoan could be unintended. On the other hand, our distant ancestors certainly were prey to big cats, as are other apes today. What’s more, in 2011 Flegr reported that infected people experience “fatal feline attraction”, too. “There is no reason to think that *Toxoplasma* is better adapted to mice than to apes,” he says.

So how can we stop this mind-controlling parasite? For now, the answer is we can’t. The main problem is that the parasite’s fatty cysts are almost impregnable to drugs. There is one way in, however. It’s unclear how, but the cysts will “swallow” molecules called transductive peptides, and in 2012, researchers led by Rima McLeod at the University of Chicago, managed to attach an active drug to these molecules and get the killer agent inside *Toxoplasma* cysts. It was an exciting discovery but funding for such work is hard to come by, says team member Bo Shiun Lai, now at the University of Cambridge. “I am hopeful that our approach might lead to an effective commercial therapy against toxoplasmosis, but this will realistically not happen any time soon.”

In the meantime, how worried should we be? Flegr believes the link between toxoplasmosis and traffic accidents, schizophrenia and possibly other mental illnesses, too, means it must have a huge economic impact. Exactly how much of an impact is unclear, but Ewald points out that the total bill for treating schizophrenia in the US is \$63 billion per year. If toxoplasmosis really is responsible for one-third of all cases

**“Does *toxoplasma* pull most strongly on human brains or human groins?”**

## MICROMANAGERS

It’s hard to assess the extent to which parasites and pathogens affect our behaviour because it would not be ethical to deliberately infect people and observe them. But Chris Reiber at Binghamton University in New York and Janice Moore at Colorado State University in Fort Collins have come up with a neat and ethically acceptable workaround - study what happens when people are exposed to pathogens through vaccination.

They have found that people were far more sociable in the 48 hours following their annual flu vaccination than in the 48 hours preceding it. “This is highly suggestive that the virus is manipulating human behaviour for its own ends; that is, to spread itself to other potential hosts,” says Reiber. Another possibility, however, is that humans subconsciously become more sociable in anticipation of needing help and support ahead of disease.

The guinea worm is another example of a parasite that may be manipulating human behaviour for its own ends, says Reiber. The nematode’s life cycle involves humans and water fleas. People ingest them in contaminated water and, a year later, the larvae emerge below their skin causing a burning sensation as they do. This encourages the infected individual to bathe, allowing the larvae to return to the rivers where it can infect a water flea.

of schizophrenia, it could easily cost the US \$20 billion each year. “Of course, this sort of estimate doesn’t take into account the non-economic, quality-of-life costs, which I consider to be even more important,” he adds.

*Toxoplasma* also presents us with an opportunity, says Shelley Adamo at Dalhousie University in Halifax, Nova Scotia. Parasites like *Toxoplasma* are “evolution’s neurobiologists”, she says. Careful study of the mechanisms they have evolved to manipulate behaviour might offer neuroscientists some handy tips on how to treat diseases and addictions. A parasite that makes its host less fearful could really come in handy. After all, excessive fear is a characteristic of many conditions - from phobias and social anxiety to post-traumatic stress. Perhaps one day we will be able to manipulate the manipulators. ■

Colin Barras is a science writer based near Ann Arbor in Michigan

# A very different kind of life

Are plants too different for humans to register them as intelligent? **Adrian Barnett** explores

*Brilliant Green: The surprising history and science of plant intelligence* by Stefano Mancuso and Alessandra Viola, Island Press, \$20

*Plant Sensing and Communication* by Richard Karban, University of Chicago Press, \$35

IN AN early *Star Trek* episode, the Enterprise is boarded by human-like aliens, with lives lived so fast that the crew can't see them. For their part, the aliens see Captain Kirk and his crew as near-static beings whose every action seems to take an age to complete.

Now think about how we view plants. With their slow-lane responsiveness, they could be ticking the boxes for behavioural brightness but they seem too slow, and too different, to register as intelligent.

This is the core of *Brilliant Green* by Stefano Mancuso and Alessandra Viola and *Plant Sensing and Communication* by Richard Karban. Plants are smart, they say, but to notice we have to overcome our ingrained cultural biases. As Karban writes: "Ask a child about the differences between plants and animals... They'll say, 'Plants can't move' or 'Plants don't do anything'."

And, as both books point out, it is but a short intellectual step to allying apparent immobility with a form of mechanistic half-life of simple growth and response – a flatlined existence devoid of subtlety, strategy and learning.

Islam doesn't consider plants alive at all, Mancuso and Viola remind us. It has a rich tradition of plant and flower illustration, alongside a ban on the physical depiction of living things. And until recently, Western medicine used "vegetative state" to describe



MARTIN BENNER/PLAINPICTURE

people considered to have lost the ability to think or be aware.

Clearly, we will never play chess with a rose, nor ask the orchid on our windowsill for advice. But that is the point: humans are guilty of serious parochialism, of defining intelligence in terms of a nervous system and muscle-based speed that enables things to be done fast, say all three authors.

Plants and animals face similar challenges: to find resources and

mates, and avoid predators, pathogens and abiotic stresses. In response, says Karban, "plants communicate, signaling within [themselves], eavesdropping on neighboring individuals, and exchanging information with other organisms". They have adaptive responses that, if they happened at speeds humans understand, would reveal them to be "brilliant at solving problems related to their existence".

The field was nearly undone by the pseudoscience of the 1970s, when notions such as "vibrations" and "energy fields" were linked with results from poorly designed

**The humble orchid is considered by most people as beautiful but dumb**

experiments testing plant sensitivity to music and the human voice, and the ability for each to influence the other's growth. Though the mechanisms behind these phenomena are now better known (and odder things, like noise-making roots, revealed), many remain sceptical about plant intelligence.

Both Karban and Mancuso have spent their careers trying to find scientifically rigorous evidence of intelligence. Karban studies plants' immune-like responses

**"Plants' lives unfold in another dimension... they are wily protagonists in the drama of their own lives"**



to attack at the University of California, Davis, while Mancuso works at the International Laboratory of Plant Neurobiology at the University of Florence, Italy.

They are in good company. From Plato onwards, many thinkers considered plants smart. After working on climbing and carnivorous plants, orchids and germinating seeds, Darwin wrote: "It has always pleased me to exalt plants in the scale of organized beings." Linnaeus actually believed that plants sleep at night.

Now microelectronics and the analysis of volatile compounds at picogram concentrations are revealing the complexities of plant behaviour as never before. So much so that Mancuso can write: "Plant lives unfold in another dimension of time" and that they are "considerably less passive than they appear, and are in fact wily protagonists in the drama of their own lives".

Plants, say the authors, are highly responsive, attuned to gravity, grains of sand, sunlight, starlight, the footfalls of tiny insects and to slow rhythms outside our range. They are subtle, aware, strategic beings whose lives involve an environmental sensitivity very distant from the simple flower and seed factories of popular imagination.

*Brilliant Green* and *Plant Sensing and Communication* are timely, highly accessible summaries of fast-developing fields. The former is a popular account (co-written with a science journalist), the latter a more technical take. Both combine a passion for plants and a desire to illustrate their largely unsung complexities with an appreciation of the burden of proof needed to persuade us of a world that contains chlorophyllic sentience.

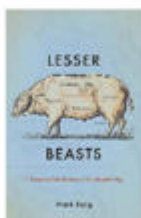
As Spock never said, it's intelligence but not as we know it. ■

Adrian Barnett is a rainforest ecologist at Brazil's National Institute of Amazonian Research in Manaus

# Let's go the whole hog

Time to dig into an old love-hate relationship, says **Jonathon Keats**

*Lesser Beasts: A snout-to-tail history of the humble pig* by Mark Essig, Basic Books, \$27.50



IN 1922, the president of the American Museum of Natural History was tricked by a pig. After receiving a 10-million-year-

old molar sent by a Midwestern fossil hunter, Henry Fairfield Osborn published a paper claiming that the tooth belonged to an "anthropoid ape". There was just one problem. Closer examination revealed that it came from an extinct relative of swine.

When the claim was discredited, creationists made Osborn's "Nebraska Man" into an icon of Darwinian folly. For Mark Essig, Osborn's error illustrates something deeper. Pigs and people have similar teeth because they have similarly omnivorous diets, he observes in *Lesser Beasts*. "And because pigs and people eat the same foods, they evolved to form a symbiotic connection."

According to Essig, this symbiosis began some 10,000 years ago, as humans started settling in villages and pigs began scavenging their waste. The pigs ate well and people got free sanitation – and they also had a nutritious meal when the pigs grew fat on their rubbish.

As civilisation grew more complicated, so did people's relationship with pigs. Over time, *Sus scrofa domestica* became the most divisive of species, deemed by some societies to be the greatest source of sustenance while others considered it the most noxious of creatures.

Essig's account is fascinating, full of erudition and nuance. He traces societal changes from the pharaohs to Walmart, using the pig. Equally, he uses history to enlarge our understanding of the domestic pig.

The high and low status of the pig, Essig believes, both derive from its "alchemical powers" to turn garbage into food. The pig is so omnivorous that it thrives practically anywhere, from deep forest to farming village to inner city, fending for itself.

This self-sufficiency was ideal for families, who could keep a few pigs with little work, but not for the ruling elites. For example, says Essig, when the pharaohs needed a supply of food to help build the Pyramids, cattle and sheep were herded in from the provinces, but pigs got left off the menu as they were too independent. "Priests and bureaucrats, who dined on lamb and beef, came to despise pigs," says Essig:

**Messy eaters: pigs' scavenging leaves us feeling ambivalent**

pork was for the rural poor.

Pigs' omnivorous diet was another major reason for their vilification. As well as truffles and scraps, pigs will consume human faeces and corpses. That makes them "a vector for the unholy", writes Essig, and repugnant to many, notably Jews and Muslims.

**"The high and low status of the pig both derive from its 'alchemical powers' to turn garbage into food"**

Today we subject pigs to harsh industrial farming, not only because they can survive the worst of environments but also because they are widely seen as impure and the food of the poor.

Essig thinks pigs' plight would improve if we could get over "the millennium-old idea that pork should be cheap". His prescription may be simplistic, but his fine book can only boost our image of *Sus scrofa domestica*. ■

Jonathon Keats is a conceptual artist and an experimental philosopher



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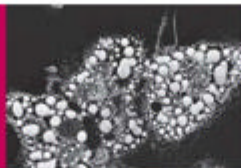
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# Cancer Prevention Fellowship Program



The National Cancer Institute (NCI) Cancer Prevention Fellowship Program (CPFP) is now accepting applications for Cancer Prevention Fellows. This is a unique postdoctoral training opportunity for scientists and clinicians in the fields of cancer prevention and control.

As part of the program, fellows receive:

- The opportunity to obtain an M.P.H. degree at an accredited university during the first year, followed by mentored research with investigators at the NCI. Research opportunities exist across the spectrum of cancer prevention research, including: epidemiology, biostatistics, clinical services, laboratory, social and behavioral sciences and engineering.
- Competitive stipends, paid health insurance, reimbursement for moving expenses, and a travel allowance to attend scholarly meetings or training.

The typical duration in the CPFP is 4 years (year 1: master's degree; years 2-4: NCI Summer Curriculum in Cancer Prevention and mentored research).

Applicants should meet the following eligibility criteria:

- Possess an M.D., Ph.D., J.D., or other doctoral degree in a related discipline or must be enrolled in an accredited doctoral degree program and fulfill all degree requirements by June 2016.
- Be a citizen or permanent resident of the United States at the time of application.
- Have no more than five years relevant postdoctoral experience.

The application deadline is August 25, 2015. To be considered, individuals must submit application via the CPFP website (<https://cpfp.cancer.gov/>)

To learn more about eligibility requirements and to apply, please visit our website <https://cpfp.cancer.gov/>

If you have specific questions, please contact [cpfpcoordinator@mail.nih.gov](mailto:cpfpcoordinator@mail.nih.gov)



## Nominate Outstanding Ph.D. Candidates from your institution

To participate in our Postdoctoral Recruitment Symposium at the Cincinnati Children's Hospital Medical Center (CCHMC). This symposium will provide a unique opportunity for outstanding senior graduate students from top graduate programs to meet and interview with faculty at CCHMC. By final invitation only, we will offer up to 20 students an expense paid visit from September 24 - 26, 2015 so that a select group of students will have the opportunity to meet with CCHMC faculty and scholars who have common research interests, or who are engaged in research programs of interest to the student. Students will present their pre-doctoral research through platform and poster sessions. In addition, we will sponsor social activities to give the students the opportunity to meet informally with faculty and postdoctoral fellows at CCHMC and to see some of what Cincinnati offers.

Download an application form/checklist at [www.cincinnatichildrens.org/education/research/postdoctoral/symposium/](http://www.cincinnatichildrens.org/education/research/postdoctoral/symposium/). To be eligible, graduate students must expect to complete their Ph.D. dissertation research between October 2015 and December 2016. Nominations are due by June 5, 2015 and must be submitted on behalf of the student by his/her dissertation advisor, department chair or Dean by Email to: [Julia.Limanowski@cchmc.org](mailto:Julia.Limanowski@cchmc.org)

Include with the complete application a letter of nomination, a CV and/or biosketch, a one-page abstract of the student's thesis research, and a summary of career goals and areas of research interest. Our faculty committee will review all nominations, and notification of acceptance will be sent via email to both student and nominator in June, 2015.

Questions? Graduating earlier than this symposium? Please contact Uma Sivaprasad ([sivgni@cchmc.org](mailto:sivgni@cchmc.org)), Postdoc Recruiter at CCHMC, about current openings.



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**Chair  
Department of Medical Biophysics**

The Schulich School of Medicine & Dentistry, at Western University, is inviting applications for the position of Chair in the Department of Medical Biophysics.

As Canada's first Department of Biophysics, the Department has grown to become one of Canada's leading centres for medical biophysics research with approximately 20 primary faculty members and over 70 actively collaborating cross appointed faculty leading internationally recognized research programs in medical imaging, microcirculation, computational modelling, biomechanics, and cancer. The department is the academic home to both undergraduate and graduate programs, including CAMPEP accreditation. It draws on a rich city-wide infrastructure incorporating two research Institutes, three hospitals, and five University Faculties. Research programs benefit from close collaborations between clinical and basic science faculty, with unique training programs in diverse fields.

The successful candidate should have a demonstrated track record of leadership and research and teaching excellence with a proven reputation for effective interpersonal and administrative skills. The new Chair will facilitate collaboration and be expected to support the research, educational and interdisciplinary initiatives of the Department. The successful candidate will build on the strength and forward momentum of the Department's graduate and undergraduate programs and promote the development of new initiatives in research, scholarship and education. He or she must have a PhD, MD, DDS or equivalent, and will receive a tenured academic appointment at the level of Associate or full Professor. Candidates with a research program complementing existing research strengths are particularly encouraged to apply. The position of Chair is for a five-year term, renewable.

Western University is located in London, Ontario, with a metropolitan census of 530,000. As Canada's 11th largest city, London boasts an extensive educational and health care community. With full time enrollment of 32,000, Western graduates students from a range of academic and professional programs. Further information about the Schulich School of Medicine & Dentistry and Western University can be found at [www.schulich.uwo.ca](http://www.schulich.uwo.ca), and <http://www.uwo.ca>. Western's Recruitment & Retention Office is available to assist in the transition of successful applications and their families. Details about the Department of Medical Biophysics can be found at <http://www.schulich.uwo.ca/biophysics/>.

Interested candidates should submit a CV outlining their research, teaching, and administrative experience and interests, including future directions, together with the names and addresses of three referees to:

**Dr. Michael Strong, Dean  
Schulich School of Medicine & Dentistry  
Room 3701A, Clinical Skills Building  
Western University  
London, Ontario N6A 5C1  
FAX: (519) 850-2357  
[selection.committee@schulich.uwo.ca](mailto:selection.committee@schulich.uwo.ca)**

Please ensure that the form available at <http://www.uwo.ca/facultyrelations/faculty/Application-FullTime-Faculty-Position-Form.pdf> is completed and included in your application submission.

**Applications will be accepted until the position is filled.  
Review of applicants will begin after September 30, 2015.**

*Positions are subject to budget approval. Applicants should have fluent written and oral communication skills in English. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority. Western University is committed to employment equity and diversity in the workplace and welcomes applications from all qualified individuals, including women and men, members of visible minorities, aboriginal persons, persons with disabilities, and persons of any sexual orientation or gender identity.*

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The Chandrasekar lab investigates the role of actin associated proteins in cell and organ function. We study membrane trafficking and endocytic mechanisms in organ specific cell types and how actin cytoskeleton regulates this process. We use cell culture methods along with advanced imaging techniques to address some fundamental cell biology questions and extend these findings to organ function in mouse models.

We are seeking highly motivated individuals with excellent problem solving skills. The ideal candidate will have a Ph.D. in molecular cell biology or related field, with some experience in microscopy/imaging techniques. Training in mouse models and mouse genetics will be provided. The position should be of interest to young scientists who want to apply cutting edge microscopy techniques and mouse genetics to study basic cell and organ biology and relate the findings to human diseases.

To view a full job description and to apply, visit [careers.sanfordhealth.org](http://careers.sanfordhealth.org) and reference job #231067.

EOE/AA

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Washington University School of Medicine is one of the top five US medical schools and is a leader in cancer genome sequencing. By mining breast cancer genomics data, the laboratory of Dr. Ron Bose identified activating mutations in the HER2 Receptor Tyrosine Kinase (see Cancer Discovery, 3:224-37, Feb. 2013). Transgenic mice and Patient-derived Xenograft models allow us to test the role of HER2 activating mutations in several solid tumors, to study interaction with other oncogenes, and to determine drug sensitivity.

We are looking for an experienced animal researcher who can lead this effort. Requirements:

- 1) Experience in transgenic mice or cancer xenograft models.
- 2) Ph.D. in molecular biology, cancer biology or related disciplines.

Email your CV and a cover letter summarizing your research experience to Dr. Ron Bose, Division of Oncology.  
**[rbose@dom.wustl.edu](mailto:rbose@dom.wustl.edu)**.

For further information: [http://oncology.wustl.edu/people/faculty/Bose/Bose\\_Bio.html](http://oncology.wustl.edu/people/faculty/Bose/Bose_Bio.html) and <http://dbbs.wustl.edu/>

## UAB THE UNIVERSITY OF ALABAMA AT BIRMINGHAM



### Postdoctoral Positions

The University of Alabama at Birmingham (UAB) is one of the premier research universities in the US with internationally recognized programs in AIDS & bacterial pathogenesis, bone biology & disease, cancer, diabetes & digestive & kidney diseases, free radical biology, immunology, lung disease, neuroscience, trauma & inflammation, and basic & clinical vision science among others. UAB is committed to the development of outstanding postdoctoral scientists and has been consistently ranked in recent years as one of the top locations among US universities for training postdoctoral scholars.

UAB is recruiting candidates for postdoctoral positions in a variety of research areas. UAB faculty are well funded (top 25 in NIH funding), utilize multidisciplinary approaches, and provide excellent research training environments that can lead exceptional candidates to entry level positions in academia, government or the private sector. Full medical coverage (single or family), competitive salaries/stipends, sick leave, vacation, and maternity/paternity leave are offered with every position as well as AD&D, disability & life insurance. Depending on the source of funding, retirement benefits may also be available. Birmingham is a mid-size city centrally located in the southeast near beaches and mountains and enjoys a moderate climate for year round outdoor activities and a cost of living rate lower than most metropolitan areas.

Visit our website at [www.uab.edu/postdocs/openings](http://www.uab.edu/postdocs/openings), to view positions. See info also on MERIT Program, an NIH IRACDA program. Send your CV to the contact name for the positions that you are interested. University of Alabama at Birmingham, Office of Postdoctoral Education, 205-975-7020.

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Department of Physics

## KANSAS STATE UNIVERSITY

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Candidates must have earned a Ph.D. (or equivalent) in physics, optics, or a related field by the time the position begins. Preference will be given to candidates with experience in one or more of the following areas: laser development (particularly optically pumped gas lasers), spatial mode analysis of lasers, power beam combining, optical frequency combs and laser frequency stabilization, optical trace gas detection, fiber lasers, and microstructured optical fibers.

The appointment will be a term appointment. The successful candidate(s) should also demonstrate a strong commitment to mentoring of graduate and undergraduate students and to serving a diverse population. Screening of applications will begin **June 1, 2015** and continue until the positions are filled. **Candidates should submit a letter of application and a vita including a list of publications to: [lumospostdoc@phys.ksu.edu](mailto:lumospostdoc@phys.ksu.edu). Candidates should also arrange to have three letters of reference sent to the same address.** For inquiries about the position, please contact Assoc. Profs. Kristan Corwin ([corwin@phys.ksu.edu](mailto:corwin@phys.ksu.edu)) and Brian Washburn ([washburn@phys.ksu.edu](mailto:washburn@phys.ksu.edu)).

Kansas State University is an EOE of individuals with disabilities and protected veterans. Kansas State University actively seeks diversity among its employees. Background check required.

## EDITOR'S PICK



## Put a selfishness tax on indulgence

From Gail Haslam Loose

I have noticed an increasing disparity in *New Scientist* between two themes: "save the planet" and "make humans happy at all costs". We moan and fret about global warming and overpopulation and in the next breath demand to live much longer lives and consume everything we want in nice convenient packaging.

Now I read about Jeff Bezos's rocket launch "with an eye on the space-tourism market" (9 May, p 6) and about the effort to create artificial rhino horn, on the grounds of satisfying people's needs instead of telling them they are wrong (p 7).

But their needs are destroying a species. And space tourism will certainly contribute to damaging our already struggling climate. We can't have it all. That's what we tell our toddlers when they want all the sweets or all the toys. We should tell ourselves the same.

Since expecting people to consider the greater good over their own is naive, what about a "selfish tax"? In the UK we could do with an influx of tax money – to save the National Health Service, to fund development of green technology, to deal with the cost of unemployment among the young.

You want to go on a rocket? Fine: there will be a huge tax on the indulgence. If you can afford space tourism in the first place, you can certainly afford the tax.

Kingstone Winslow, Wiltshire, UK

## A universe not made for humans

From Nathaniel Hellerstein

Michael Slezak says that the universe is fine-tuned for life (2 May, p 32). Balderdash. Inspection of the night sky reveals that the universe is almost entirely cryogenic pitch-black irradiated empty space, void of life, or indeed of anything much. To a high order of approximation, the universe resembles a vacuum.

The universe isn't 100 per cent lifeless, but 99.999999999 per cent lifeless is pretty good fine-tuning. I deduce that the universe is fine-tuned not for life, but against it. I call this the Misanthropic Principle. *San Francisco, California, US*

From Lawrence D'Oliveiro

When considering whether our universe is fine-tuned for life, we need to consider all the possible physical parameters that go into defining a universe. Think of them arrayed in a multi-dimensional space of all possible universes, with our universe occupying one point in that space.

Our universe lies within a subset of the larger space, in which life can exist. We can make a simplifying assumption that this life-friendly subspace is compact and is contiguous within the larger space of possible universes; let's say its shape is a hypersphere.

In mathematics, if you choose a point at random within a hypersphere of  $N$  dimensions, then as the number of dimensions increases so do the odds that your chosen point lies close to the surface of the hypersphere – beyond which, in this case, no life can exist.

How many dimensions are we talking about? 100? 1000? The number is more likely to be larger than smaller. The more dimensions, the stronger the effect.

In other words, if our universe was created at random, but within

the subset of universes in which we can exist, then the odds are very high that it is close to the edge where no life can exist.

Given the seeming uniqueness, and precarious hold, of life on Earth, this is exactly consistent with what we observe. *Hamilton, New Zealand*

## Is humanity to be defended against?

From Virginia Strauss

Anders Sandberg of the University of Oxford's Future of Humanity Institute feels that "If we think we are the only life in the universe, we have a huge responsibility to spread life to the stars" (2 May, p 37). He supposes our presence here has been for the planet's long-term good – but has it?

Maybe any higher intelligence out there will, having watched the police series *Z Cars* and then the film *Apocalypse Now* beamed from Earth (2 May, p 36), deduce that they have a nasty little virus on their hands. Are our instincts for preserving ourselves and adopting new habitats any different from those of HIV?

Maybe our intelligence will be viewed from afar in the same way that we admire the mutational prowess of flu viruses. And maybe by the time they get to the film *Blade Runner* they will be devising some form of antiviral to launch at us.

*West Moors, Dorset, UK*

## Careful with that lab, Eugene

From John Marshall

Michael Brooks asks whether we could destroy the fabric of the cosmos (2 May, p 35). Do we have here a solution to Fermi's paradox concerning the lack of signs of extraterrestrial life?

If measuring and collapsing a fundamental quantum state

destroys the measurer, then each civilisation would be the only life form in a universe that should be teeming with life – until they make that fateful measurement. *Southend, Essex, UK*

## A universo-centric view is needed

From Ian Flitcroft

The contributors to your group Leader "The universe is ours" mostly took an anthropocentric approach (2 May, p 5). I suggest that as intelligent creatures we should adopt a loftier viewpoint – the universo-centric one.

If the universe is to be colonised by an intelligent organism, what type of creature would be best suited to look after its interests? It would be a triumph of hope over history to think that humans are the ideal choice.

We continue to fight wars for spurious reasons with ever more ingenious weapons. Profit reigns supreme over sustainability. And we have done an appalling job of looking after that infinitesimally small corner of the universe that we claim as ours – Earth.

When it comes to engaging with other alien species, we don't have to look too far back into our past to see how badly that might turn out. We haven't yet learned to treat other *Homo sapiens* with equality, dignity and respect; and the species we see as "lesser" have all too frequently been exploited or made extinct.

*Dublin, Ireland*

## Seed banks are not nearly enough

From David Barnard

If we ever have to use seed banks to revive agriculture (see for example 3 January, p 23), will we also need to revive pollinators from insect banks?

*Cholesbury, Buckinghamshire, UK*



**"I think I've spotted a flaw in the 'secret' part of 'secret plane'"**

Gav tweets about our report of the Boeing X-37B launch (23 May, p 7)

## Getting to the heart of ownership

From Dave McGlade

Mabs Taylor reminds us in her letter that the question "who owns the assets" is an interesting problem with head/body transplants (18 April). What I find equally interesting is that no one considers it a relevant question for any other transplant.

Southampton, Hampshire, UK

a good proxy for the subjective utility (or happiness) expressed in the willingness to pay them.

But inequality fundamentally undermines the validity of this proxy. The law of diminishing marginal utility means that additional money provides less happiness than the initial sum. Less subjective utility is needed to motivate the spending of the rich than that of the poor. Rising GDP is a misleading proxy for well-being if inequality is ignored.

Eden Hills, South Australia

brought together, or that it was necessary to follow the recipe exactly to get the desired results?

Do people really think that the ability to think and observe regularities only arose in the last, say, 150 years? One person's ignorance of a subject doesn't mean that other people's knowledge is worthless.

Penshurst, New South Wales, Australia

severely vocally chastised her. A perfect example of the teaching of road sense.

Melbourne, Australia

## Pricing happiness out of the market

From Constance Lever-Tracy

You featured two interesting opinion pieces side by side: Ha-Joon Chang's discussion of inequality (25 April, p 28) and Richard Layard's call for a measure of general well-being (GWB) to supplement that of gross domestic product, or GDP.

Economic theory may seem to make the GWB redundant, since GDP is composed of market prices, and these are taken to be

## People in the past were not stupid

From Rosemary Sharples

I was interested to read about an Anglo-Saxon remedy that could kill MRSA (4 April, p 14) but, as ever when I read such articles, I asked myself "why are people surprised that our ancestors found a solution to a problem?" Why do people think old ideas must be crazy? And why is it unexpected that the ingredients had little effect until they were

## More creatures of the crossing code

From Rod Cripps

I read with interest your article about smart chimps looking both ways before crossing a road (25 April, p 19). We have a local family of four Australian magpies. They come for a feed of minced meat every morning.

One morning, when the chicks were younger, one ran out onto the road. Mother magpie immediately rushed out and grabbed the youngster by the neck-feathers, dragged her back to the side of the road and

## Paracetamol as panacea or placebo

From Jennifer Hush

You mention that paracetamol "blunts emotions" (18 April, p 7). For several years, on occasions when for no reason I felt negative, anxious or stressed, I would take two paracetamol. In 20 to 30 minutes I felt back to normal. I just assumed it was all in my head.

Edinburgh, UK

## Robots are all tax avoiders

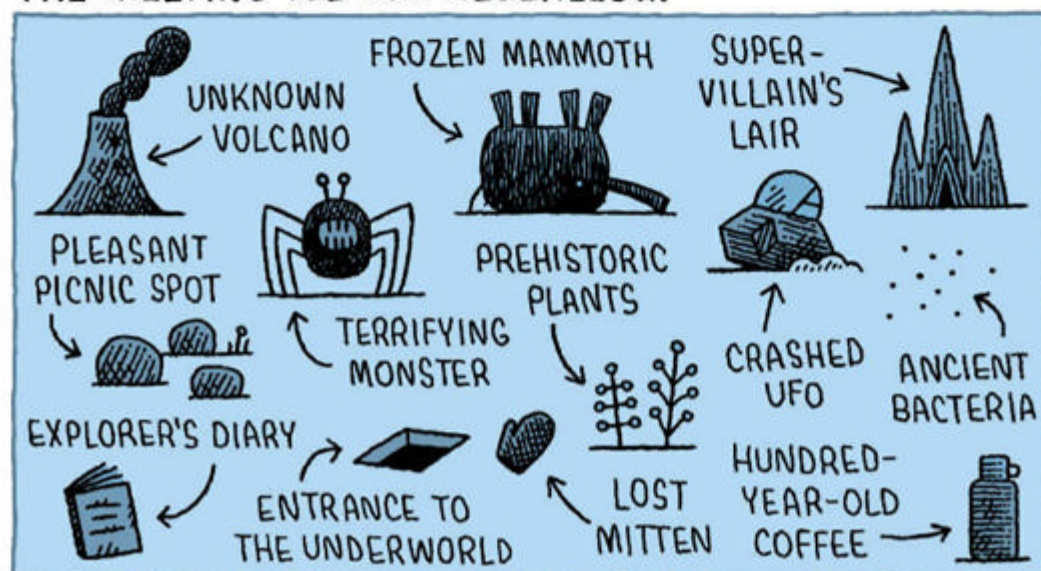
From Martin van Raay

David Gullen's letter has a point about the economy-destroying power of robots – even more than he states (25 April). When you replace a tax-paying taxi driver with a driverless car, who is going to pay the unemployment benefit of the former driver? Robots don't pay taxes.

Culemborg, The Netherlands

TOM GAULD

## THE MELTING ICE HAS REVEALED...



## For the record

■ We should have said that Marshall Nirenberg and Heinrich Matthaei began to break the nucleic code using artificial RNA, made only of the base uracil, to make the peptide polyphenylalanine from the amino acid phenylalanine (2 May, p 46).

Letters should be sent to:  
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IT CAN be nice when people believe science has inspired their art. Can be. Consider "intermedia" artist Adam Brown's installation *ReBioGeneSys*, which he announces is "theoretically capable of forming the self-organizing chemistries necessary to produce semi-living molecules and perhaps even protocells".

Brown had detected a flaw in an earlier work based on a primordial soup of chemicals: namely, there was nothing forcing these to do anything. So *ReBioGeneSys* is designed to "torture the chemicals within (by freezing them, heating them back up and so on) in the hopes that more complex life will eventually form".

"Think of it like soup," writer John Brownlee reports Brown saying. "The more you boil it down, the deeper the flavor becomes because the molecules draw closer together." That last bit makes Feedback somehow doubt the nature of the "experiment" - and reluctant to taste Adam's soup.

DIMENSIONS exert a fascination over marketing creatures. Sönke Hardersen saw an advert for a jacket boasting "six-dimensional elasticity". We now find that Mick Cooke sent the same ad earlier, having received it with the same running socks. Sönke "can only envy those sporty people who are able to move in six dimensions".

Perhaps they can, if we include rotation around three axes as well as motion in the three familiar dimensions. But how does that relate to elasticity? Multi-dimensional wringing out?

THE above six-dimensional advert blurb is far from a record. Philip Knight draws our attention to a report in a London free newspaper that its associated TV channel will be presenting theatre filmed live with the latest technology. Specifically: "Nikon has also developed a nine-axis robotic arm". Philip presumes that the

images captured along the nine axes will be broadcast in nine dimensions. But can they be watched on boring old two-axis screens, he wonders?

Bending over backward in several dimensions to be fair, Feedback discovers that multi-axis robots are not rare. We suspect the "nine" reference is to the number of pivots between the floor and the lens.

PROBABLY over-egging the multi-dimensional pudding is the "4D designer dress" to which Guillem Southwood alerts us. For added shock-of-the-new, this is the output of a 3D printer. Some readers will already have guessed that the fourth dimension could well be time: in particular, the time to assemble a slightly crunchy lace dress from 2279 printed panels connected by 3316 hinges. Shiny technology. Making life simpler, again.

SUCH multidimensional phenomena occasionally wake Feedback with a start in the middle of the night. We are not alone. Pat Jeater reports opening a new tube of toothpaste that offered "a new dimension of whiteness" and sensibly deciding that 11.30 pm was not the time to ponder this.

Unfortunately, 3.30 am was the time, according to Pat's dreaming brain. It mulled, for example: Will these extra dimensions keep on accumulating the more I brush my teeth with this new toothpaste? What happens to the gums around these newly dimensioned teeth? How will they cope when the teeth have extra dimensions? Just who is in charge of allowing all of these new dimensions?

OTHER objects offered for sale seem to be dimension-deficient, such as the sheets of wax that Dave Goodwin was looking up, described as: "Size (L x W x H): 16.00 in x 8.00 in x 0.00 in". We find that there is a £3.75 delivery charge to discover what these two-dimensional sheets weigh.

THE TV industry has largely given up on promises of multiple dimensions and now has yet another new mantra:

"Not just more pixels, but better pixels". The marketers' problem is that few people can actually see the extra detail in their newest, flashiest sets unless they sit very close or the screen is very, very bright.

A colleague found a demonstration unpleasant, especially when the image flashed, and wondered about the possible risk of this triggering photo-epilepsy or migraines. One company said, yes, this was being looked into - but no, they could not identify the university doing the work.

Then in the tea break at a tech conference a senior engineer from a UK TV station confided the reason: "We are very aware of the risks and would love to do some real research. But nobody dares do it because it would involve tests that deliberately push subjects into epileptic fits, and might very possibly kill them."

FINALLY, James Loch sends a literary - if not fine-art - template for multidimensional mayhem. H. P. Lovecraft's *At the Mountains of Madness* was serialised in *Astounding Stories* in 1936, six years after the debut of his trademark being, Cthulhu. It



recounts the adventures of some unfortunate Antarctic explorers.

As they finally escape, one of the harried adventurers looks back a final time. He gets a glimpse of a far city, whose features include "the windowless solids with five dimensions".

You can send stories to Feedback by email at [feedback@newscientist.com](mailto:feedback@newscientist.com). Please include your home address. This week's and past Feedbacks can be seen on our website.

Martin Albu reports that a club he belongs to boasts that its membership card is biodegradable and "should last a lifetime". For some reason he finds this worrying



## Clouding the issue

Are there any wavelengths at which the sun still casts a shadow when the sky is full of clouds? Could I make a sundial that would work on a cloudy day?

Some radio waves can go through clouds and the sun does emit radio waves, so it would be possible to build a sundial that works on shady days. But you would need a sundial that was large in comparison to the wavelength of the radio waves in question, otherwise the waves

One way to work out the position of the sun – and thus to deduce the time – when conditions are overcast is to observe the polarisation of what light is available. This phenomenon is something that insects and birds exploit for navigation.

In general, scattered light is polarised at right angles to the sun. So, when the sun is at its highest point, light is close to being horizontally polarised along the entire horizon. When the sun sets directly west, the sky will be vertically polarised at the horizon due north and south.

In 1848, English inventor Charles Wheatstone presented the “polar clock”, a sundial-like device that could be used when it was cloudy. By angling the tube towards the North Pole, and turning a prism in the eyepiece until the light vanished, the relative angle of polarisation of available daylight could be deduced, giving the position of the sun and thus the approximate time.

It has also been suggested that Vikings used crystal “sunstones” to locate the sun when it was obscured by clouds or just over the horizon.

*Mike Follows  
Sutton Coldfield, West Midlands, UK*

## This week's questions

### HAVING A BALL

We found this object (see photo, above) by a sea wall in south-east Thailand. The white substance



looks like a folded piece of fabric made out of limestone encrusted with glassy spheres. Only a tiny section of each sphere is attached to the limestone, but they are held firmly in place and cannot be removed with a fingernail. None of them has a surface scratch, which is impressive considering they must have been bashed by waves against the rocky sea wall. What are these tiny spheres?

*Natam Tonkul  
Bangkok, Thailand*

### EVERYTHING BUT THE CURL

I've been making notes to revise for my exams, and as I write, the pages curl inwards first from the top corners of the

paper, and then the bottom corners. Why is this? I'm using a black ballpoint pen on white A4 printer paper.

*Gurleen Kaur  
By email, no address supplied*

### SELECTED SELECTIONS

The only genetic changes in humans we ever hear about are those producing diseases such as cystic fibrosis. Has anyone identified any genetic changes within recent generations that make individuals possessing them “more fit” to thrive in today's environment? Would we even know these changes if we saw them? And would we consider them normal for healthy humans?

*Colin Bamforth  
Altrincham, Cheshire, UK*

### RAILING AGAINST IT?

Edinburgh finally got its tram system last year, which was over-budget and behind schedule. Most of the problems were due to having to lay the rails in the road.

### “Why didn't Edinburgh go for trolley buses powered by overhead wires instead of trams?”

Why didn't Edinburgh and other UK cities go for trolley buses – electric buses powered from overhead wires – instead of trams?

*Jim Logan  
Castle Douglas, Dumfries and Galloway, UK*

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